Chapter 3
Surface Water Quality

Introduction

The Central Valley is divided into three major surface water basins: the Sacramento River Basin Watershed, the San Joaquin River Basin Watershed, and the Tulare Lake Basin Watershed (Figure 1-1). Each of these three basins is divided into subwatersheds delineated by DWR CalWater boundaries, or a hybrid of these boundaries if the hybrid was determined to be more accurate in defining the watershed. This section identifies the three basins along with the 30 subwatersheds and all scientific methods used to assess the surface water conditions of the basin.

Organization and Elements

Sacramento River Basin Watershed (Figure 3-1)

1. Pit River Subwatershed
2. Shasta-Tehama Subwatershed
3. Upper Feather–Upper Yuba River Subwatershed
4. Colusa Basin Subwatershed
5. Butte-Sutter-Yuba Subwatershed
6. Lake-Napa Subwatershed
7. Solano-Yolo Subwatershed
8. American River Subwatershed

San Joaquin River Basin Watershed (Figure 3-2)

1. Delta-Mendota Canal Subwatershed
2. San Joaquin River Subwatershed
3. San Joaquin Valley Floor Subwatershed
4. Delta-Carbona Subwatershed

5. Ahwahnee Subwatershed
6. Mariposa Subwatershed
7. Upper Mokelumne–Upper Calaveras Subwatershed
8. Merced River Subwatershed
9. North Valley Floor Subwatershed
10. Stanislaus River Subwatershed
11. Tuolumne River Subwatershed
12. Cosumnes River Subwatershed

Tulare Lake Basin Watershed (Figure 3-3)

1. Kings River Subwatershed
2. Kaweah River Subwatershed
3. Kern River Subwatershed
4. South Valley Floor Subwatershed
5. Grapevine Subwatershed
6. Coast Range Subwatershed
7. Fellows Subwatershed
8. Temblor Subwatershed
9. Sunflower Subwatershed
10. Southern Sierra Subwatershed

General Sources of Information

Surface Water Quality Data Collection and Methods

Collection of resources and data for surface water quality descriptions was accomplished by using various state and federal agency websites, water quality reports from various water quality coalitions, and other hard copy reports. Most of the surface water information came from existing reports. Because this existing conditions report covers such a large geographical area, however, information to assess a particular watershed was often insufficient. In those cases, best professional judgment and technical hydrological experience were used in the analysis.

Many types of data for surface water analysis are available from government agencies (e.g., DWR, USGS, Reclamation) that routinely measure river flow, temperature, salinity, and other water quality parameters. Different agencies have collected data during various time periods, at different stations and with different parameters. These data are stored in various public and private databases operated by multiple agencies. This makes it difficult for stakeholders, agencies, or interested persons to access the full range of available data. Each type of data must be individually downloaded, processed, compiled, and compared.

Agency databases have different sets of procedures for downloading data. Some databases offer web-based retrieval, and others are stored on a compact disc (CD) (e.g., USGS and EPA). Some databases have interactive maps, while others allow only text or number searches for station names or identification numbers, respectively. Without a map it is difficult to identify station locations or names. Some databases are not publicly viewable and must be accessed through individual agency staff. In short, each database has its own accessibility features and constraints. This section identifies the sources of information and the techniques and methods associated with the data collection.

California Data Exchange Center

The California Data Exchange Center (CDEC) (http://cdec.water.ca.gov) is maintained by DWR, through the Division of Flood Management. It contains current and historical flow, water quality, and meteorological datasets for all of California. Users locate individual stations through a user-friendly map interface. Once the desired stations are located, a user may download one parameter from one station at a time, and the same limitations apply to downloading 3 or 4 years of hourly or 15-minute data at a time. After the data sequence is displayed on the screen, the user may select to save it to a file, or select a spreadsheet program to open it directly.

United States Geological Survey

The USGS maintains a database of current and historical flow and water quality data from many flow and water quality stations in California. These data can be accessed on the Internet at <http://water.usgs.gov/data.html>, as well as on a CD database product that is updated annually by a commercial vendor (Hydrosphere Data Products). This same vendor has a CD product with the EPA water quality database, called STORET. However, it is important to note that sometimes data between stations do not cross over between the website and the Hydrosphere product.

The USGS website has current and historical flow and water quality (i.e., grab sample) datasets. Hourly or 15-minute flow, stage, electrical conductivity (EC), and temperature data are available in the real-time portion of the database. Stations can be selected by state, station name, identification number, period of record, etc. Once a station is selected, individual parameters can be saved in a tab-separated file and then opened in a spreadsheet and error-checked. This USGS website is one of the more user-friendly database interface and retrieval systems available.

Bay Delta and Tributaries Project

Like the CDEC, the Bay Delta and Tributaries Project (BDAT) website (http://baydelta.water.ca.gov/index.html) is maintained by DWR. It consists of a database of water quality and meteorological datasets provided by more than 50 organizations. Although a map-based user interface to select data by location is being developed, data locations must currently be specified by location or ID code. This means that the user must already know the locations that are desired. Once a station is selected, the desired parameter(s) can be downloaded as an Excel file and then opened on the user's computer.

Land Use Data Collection and Methods for Subwatershed Boundaries

Derivation of Subwatershed Boundaries

Subwatershed boundaries were derived from the California Interagency Watershed Map of 1999 (CalWater 2.2.1). Updated in May 2004, CalWater 2.2.1 is the State of California's working definition of watershed boundaries, beginning with the division of the state's 101 million acres into ten Hydrologic Regions (HRs). Each HR is progressively subdivided into six smaller, nested levels: the Hydrologic Unit (HU—major rivers), Hydrologic Area (HA—major tributaries), Hydrologic Sub-Area (HSA), Super Planning Watershed (SPWS), and Planning Watershed (PWS). At the PWS level, where implemented, polygons range in size from approximately 3,000 to 10,000 acres.

With the exception of the Sacramento Basin, subwatershed boundaries were derived for the current project by using HU boundaries. Where applicable, HUs were lumped into regions with similar hydrology and land use characteristics. All boundaries in each subwatershed boundary dataset, including the Sacramento Basin, were derived from some level of CalWater 2.2.1, whether it was HU, HSA, or PWS.

The San Joaquin River Basin Watershed was also derived from CalWater 2.2.1 boundaries. However, some of the subwatersheds were combined to reduce the amount of redundancy in the delineations. Tulare Lake Basin Watershed boundaries also used CalWater 2.2.1 and were not altered.

Compilation of California Department of Water Resources Spatial Data

Jones & Stokes obtained the most current data available for each county covered under the jurisdiction of the Region V Water Quality Control Board. Data were downloaded from the DWR Land and Water Use website (http://www.landwateruse.water.ca.gov/basicdata/landuse/digitalsurveys.cfm). For each basin (Sacramento, San Joaquin, Tulare), countywide data were aggregated into one dataset and then checked for matching edges; sliver polygons were repaired where necessary. Slivers were converted to the nearest land use classification where easily discernable. In ambiguous cases, they were classified as native vegetation. These sliver errors at county boundaries accounted for less than 0.035% by area within each basin (0.017% for Region V as a whole).

Supplemental Spatial Data (California Department of Forestry and Fire Protection, Fire Resources Assessment Program Vegetation)

There are several counties within Region V for which DWR land use spatial data are incomplete or unavailable. In order to represent the entire Region V jurisdiction, the DWR land use data have been combined with the California Department of Forestry and Fire Protection (CDF) Fire Resources Assessment Program (FRAP) GIS layer (Multi-source Land Cover Data v02_2). This GIS dataset was chosen from many available sources because it has the broadest and most complete coverage of California, as well as having been peer reviewed and well documented. Readers are encouraged to visit the FRAPVEG site (http://frap.cdf.ca.gov/projects/frap_veg/index.html), which has detailed documentation on methods, links to sites with the source data used in FRAPVEG, and an update schedule.

The FRAPVEG dataset uses the California Wildlife Habitat Relationships (CWHR) system classification, which is different from the DWR classification system because it focuses on land cover rather than land use. In order to develop uniform calculations and maps for this report, the FRAPVEG GIS data were reclassified to more closely represent the DWR land use classes (Table 3-1 below).

Table 3-1. Reclassification of FRAPVEG Classes to DWR Land Use Types

FRAPVEG—Whr10Name	DWR Reclassification
Agriculture	Pasture
Barren/Other	Barren
Conifer	Native Vegetation
Desert	Native Vegetation
Hardwood	Native Vegetation
Herbaceous	Native Vegetation
Shrub	Native Vegetation
Urban	Urban
Water	Water Surface
Wetland	Wetland*

* Classification does not exist in DWR Land Use Data.

Calculations and Statistics

All calculations were performed using ESRI ArcGIS 9.1. A wide variety of geoprocessing tools were used to compile and analyze the data for this report, including *Merge*, *Intersect*, and *Erase*. All areas were calculated using *Summarize* or *Frequency* on tabular data and converted to appropriate units using Microsoft Excel.

Coordinate System

All spatial data are stored in Geodatabase format using the Teale Albers projection, NAD 1983 datum. For more information on the parameters of this coordinate system, visit <http://gis.ca.gov>.

The following pages of this chapter provide a description of general characteristics, surface water flows, land use patterns, basin plan status, and surface water quality for each of the subbasins within the three major basins in the Central Valley Water Board's region.

Sacramento River Basin—
Pit River Subwatershed

General Description

The Pit River Subwatershed is located in northeastern California at the western edge of the Great Basin Province, partially bordering Oregon. The subwatershed encompasses approximately 4,700 square miles, the majority of which is in Modoc County with acreage in Lassen, Siskiyou, and Shasta Counties (DOI 2003). The general topography of the subwatershed varies significantly, with elevations from 14,162 feet atop Mount Shasta, to 9,892 feet in the rugged Warner Mountains down to the lower elevations of the Fall River Valley (SVWQC 2004). The McCloud River and the Sacramento River are also located in the Pit River Subwatershed and make up the north and middle forks of Lake Shasta. Figure 3-4 includes the entire Pit River Subwatershed and maps all major water bodies in it.

Average annual temperatures in the subwatershed range from a low of approximately 30ºF to a high of 63ºF. Summertime maximum temperatures can reach over 100ºF, but common temperatures range from 90 to 100ºF. Typically, the last frost occurs in May and the first frost occurs in September.

Pit River

Drainage in the Pit River portion of the subwatershed originates with the North and South Forks. The North Fork originates at Goose Lake, which is an enclosed basin except during rare events when it spills over into the North Fork. The South Fork and its tributaries originate in the southern Warner Mountains and Moon Lake in Lassen County. The North and South Forks of the Pit River converge in the town of Alturas in Modoc County and then flow in a southwesterly direction into Shasta Lake in Shasta County (SVWQC 2004). The Fall River is a major tributary to the main Pit River, entering at Fall River Mills upstream of Lake Shasta. In addition to the Fall River, there are many small tributaries to the Pit River. Water quality in these smaller tributaries has not been assessed, and the Pit River is considered representative of the entire Pit River portion of the subwatershed.

The USGS currently maintains six gauging stations in the Pit River Subwatershed, including a site on the South Fork of the Pit River near Likely (USGS 11345500), and the mainstem of the Pit River near Canby (USGS 11348500). Real time data are available at the Likely and Canby stations, and they are the two stations used for flow information in this report.

The drainage area to the Likely station encompasses 247 square miles, while the drainage area to the Canby station is approximately 1,431 square miles, or about

42% of the Pit River Subwatershed. Average annual flow at the Likely station between 1929 and 2005 was 49.5 cubic feet per second (cfs), and average annual flow at the Canby station between 1932 and 2001 was 257 cfs (USGS 2005). Table 3-2 includes data from 1995 to 2004 and shows the minimum, the mean, and maximum monthly flows for this 10-year period. A longer period of record was not used because of recent changes in flow associated with agriculture and other diversions. USGS has also collected flow data for Fall River; however, the most complete record started in 1958 and stopped in 1967. The USGS station is Fall River near Dana, California (11353700), and the calculated annual average flow is 483 cfs (USGS 2005). This USGS flow gauge is close to the headwaters and is not representative of the entire Fall River flow. No better record is available.

Table 3-2. Monthly Average Flow (cfs) for the Pit River, the McCloud River, and the Upper Sacramento River

	Pit River at Canby			McCloud River above Lake Shasta			Sacramento River at Delta Ca		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	71	443	1,625	342	2,054	5,093	430	3,105	7,188
Feb	75	527	1,686	725	2,064	4,777	1,421	3,257	7,116
Mar	67	519	1,276	763	1,688	4,847	1,189	2,881	6,639
Apr	78	400	842	543	1,076	2,231	1,356	2,332	3,386
May	10	695	2,188	359	806	2,050	912	1,926	3,718
Jun	8	321	1,624	270	521	1,514	409	1,068	3,672
Jul	1	59	193	225	357	565	235	440	1,145
Aug	3	45	103	200	306	538	205	309	548
Sep	11	71	209	220	301	547	203	287	602
Oct	15	98	247	231	303	549	206	303	613
Nov	48	123	388	232	433	1,020	265	640	1,340
Dec	69	198	416	311	1,131	3,533	307	1,850	5,754

Flows are in cfs and monthly average flows from 1995 to 2004.

Sources: Data for the Pit River at Canby were obtained from the USGS website at <http://waterdata.usgs.gov/>. Data for McCloud and Sacramento River were obtained from the CDEC website at <http://cdec.water.ca.gov/>.

McCloud River

The McCloud River originates above Lake McCloud in Siskiyou County and terminates at the Middle Arm of Lake Shasta in Shasta County. The McCloud River Watershed includes roughly 800 square miles. The McCloud flows southwesterly for approximately 50 miles until its terminus at Lake Shasta (LMRWA 1998).

The McCloud River is the dominant hydrologic feature in the McCloud Watershed and drains through the steep, mountainous terrain between Lake McCloud and Lake Shasta. The Pit River Hydroelectric Project Dam at Lake

McCloud regulates streamflow into the river to maintain minimum flows for fish habitat (LMRWA 1998). A portion of the McCloud River is diverted from this facility to the Pit River for power generation.

The CDEC contains flow data on the McCloud River. For this analysis, flow data at McCloud River above Lake Shasta were used because it is the farthest downstream location prior to the river's confluence with Lake Shasta and therefore is representative of the flow for the entire watershed. Table 3-2 shows monthly average flows from 1995 to 2004 for this location.

Upper Sacramento River

The Upper Sacramento River above Lake Shasta drains an area of approximately 400 square miles. The Sacramento River headwaters start around the southwestern slopes of Mount Shasta and the Trinity and Klamath Mountains. The upper river's flow is collected behind Box Canyon Dam, which maintains a relatively constant flow downstream all summer while becoming "run of the river" during high flow events. The Sacramento River is deeply incised into the steep mountain terrain and primarily flows over bedrock. There are approximately 40 river miles between the headwaters at Box Canyon Dam and Lake Shasta (DOI 2003). The CDEC includes flow data on the Upper Sacramento River near Delta, California. For this analysis, flow data at Sacramento River above Lake Shasta were used because it is the farthest downstream location prior to the river's confluence with Lake Shasta and is considered representative of the flow for the entire Upper Sacramento River Basin. Table 3-2 (see below) shows monthly average flows from 1995 to 2004 for this location.

Lake Shasta/West Squaw Creek/Little Backbone Creek/Horse Creek

The overall water quality of Lake Shasta is excellent with the exception of the inflows from West Squaw Creek and Little Backbone Creek on the west side of the lake and Horse Creek, which enters the Squaw Creek Arm in the eastern portion of the lake. The lower reaches of West Squaw Creek, Little Backbone Creek and Horse Creek are impacted from acid mine drainage issuing from the portals of abandoned copper mines. Acid mine drainage is characterized by low pH and elevated concentrations of metals toxic to aquatic life. The metals concentrations within these watercourses is sufficiently elevated to eliminate fisheries in the lower reaches, but they do contain aquatic life tolerant to metals and low pH conditions. The creeks' impact on Lake Shasta has been significantly reduced over the years by implementation of remedial activities at the abandoned mines. Historical large-scale fish kills in Lake Shasta at the mouths of the streams have been eliminated. These creeks are not discussed in detail because these effects are not a result of irrigated agriculture.

Land Use Patterns

Land use has changed little in the subwatershed during the last 68 years. About one-half of the acreage is privately owned, consisting predominantly of production agriculture (ranching, hay/alfalfa, and wild rice), timber, and livestock grazing, while approximately 56% of the subwatershed is held by U.S. Forest Service (USFS), Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (DFG) (SVWQC 2004). Traditionally, timber management, livestock grazing, and mining have been the focus of land management in the region. In recent years, land management plans have deemphasized timber and livestock production and focused more closely on watershed management and preservation of wildlife habitats (SCWQC 2004).

In addition to agricultural land uses, wildlife refuges make up portions of the subwatershed. One national wildlife refuge (Modoc National Wildlife Refuge) is located in the northern part of the subwatershed, and another state-owned wildlife area (Ash Creek) is located in the middle portion. An additional reserve owned by the state, Ahjumawi Lava Springs State Park, is located in the southwest portion of the subwatershed (SVWQC 2004).

Agricultural land use in the Pit River Subwatershed includes a variety of common crops such as alfalfa hay, alfalfa/orchard grass hay, timothy hay, assorted grass hay, oats, barley, wheat, irrigated pasture, strawberry nursery plants, wild rice, peppermint, garlic, onions, and assorted vegetable seed (SVWQC 2004).

Agriculture is the largest water consumer in the Pit River Subwatershed. According to the USGS National Water Use Program, it is estimated that approximately 230,000 acre-feet of surface water is diverted annually in the Pit River subwatershed for irrigation purposes (USGS 2003). Approximately 170,000 acre-feet of that are lost to evapotranspiration (USGS 2003). Various methods of irrigation are used, including flood, pivot, wheel-line sprinklers, and hand-line sprinklers. Wild rice uses a flood method that inundates the plant roots under at least 6 inches of water throughout the entire growing season.

The DWR land use map (Figure 3-12) depicts land use data for the entire subwatershed. The Pit River and Fall River Watersheds contain nearly all of the irrigated land use within the subwatershed, with virtually no irrigated land in the McCloud River and Upper Sacramento River Basins. Table 3-3 below presents acreages in the Pit River Subwatershed by land use type according to DWR land use data. Pasture, idle, grain/hay crops, semi-agriculture, and some small field crops make up the majority of irrigated agriculture in the Pit River Subwatershed.

Table 3-3. Land Use Acreage in the Pit River Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Rice	6,673	0.15
Deciduous Fruits and Nuts	138	0.003
Field Crops	1,025	0.02
Grain and Hay	17,018	0.38
Pasture	132,717	2.97
Truck, Nursery, and Berry Crops	989	0.02
Idle	15,998	0.36
Semiagricultural and Incidental	2,524	0.06
Subtotal	177,082	3.96
Urban		
Urban—unclassified	3,348	0.07
Urban Landscape	514	0.01
Urban Residential	9,388	0.21
Commercial	1,763	0.04
Industrial	1,726	0.04
Vacant	1,291	0.03
Subtotal	18,030	0.40
Native		
Native Vegetation	4,102,190	91.84
Barren and Wasteland	381	0.01
Riparian Vegetation	23,149	0.52
Water Surface	146,018	3.27
Subtotal	4,271,738	95.64
Total	**4,466,849**	**100.00**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Pit River Subatershed. Table 3-4 lists the beneficial uses of the Pit River, Goose Lake, Fall River, McCloud River, and the Sacramento River.

Table 3-4. Beneficial Uses by River

Beneficial Uses	Goose Lake	Pit River	Fall River	McCloud River	Sacramento River (to Box Canyon)
Municipal & Domestic	E	E	E	E	
Irrigation		E	E		E
Stock Watering		E	E		E
Process					
Service Supply					
POW (Power)	E	E	E	E	
Rec-1	E	E, P	E	E	E
Rec-2	E	E	E	E	E
Freshwater Habitat—Warm		E	E		
Freshwater Habitat—Cold	E	E	E	E	E
Migration—Warm					
Migration—Cold					
Spawning—Warm		E	E		
Spawning—Cold	E	E		E	
Wildlife Habitat	E	E	E	E	E
Navigation					

P = Potential, E = Existing, U = Undefined.

Data obtained from the Sacramento–San Joaquin River Basin Plan. Rec-1 is contact and canoeing or rafting, and Rec-2 noncontact.

Impaired Status

The federal Clean Water Act (CWA) Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Pit River is listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. According to the 303(d) list of water quality–impaired rivers, the Pit River is impaired for nutrients, organic enrichment/low dissolved oxygen (DO), and temperature. The Fall River is 303(d) listed as impaired for sedimentation/siltation. As a result of mining activities, Lake Shasta near the Squaw Creek location is listed as impaired for cadmium, copper, and zinc. West Squaw Creek and Horse Creek are listed as impaired for cadmium, copper, lead, and zinc. Little Backbone Creek is listed as impaired for acid mine drainage, cadmium, copper, and zinc. Table 3-5 contains the total maximum daily load (TMDL) priority status for the Pit River, Fall River, and Lake Shasta. Potential sources of the following impairments are considered to be agriculture, grazing, silviculture, resource extraction, and highway/bridge construction.

Table 3-5. Impaired Designations by River Sub-Areas

Watershed	Pollutant	Potential Sources	TMDL Priority	Affected Size
Pit River	Nutrients	Agriculture—Agricultural Grazing	Low	123 miles
	Organic Enrichment/ Low Dissolved Oxygen		Low	
	Temperature		Low	
Fall River	Sedimentation/Siltation	Agriculture—Agricultural Grazing, Silviculture, Highway/Road/Bridge Construction	Low	8.6 miles
Lake Shasta (where West Squaw Creek Enters)	Cadmium	Resource Extraction	Low	20 acres
	Copper		Low	
	Zinc		Low	
West Squaw Creek (below Balaka Mine)	Cadmium	Resource Extraction	Low	2 miles
	Copper		Low	
	Lead		Low	
	Zinc		Low	
Horse Creek (Rising Star Min to Shasta Lake)	Cadmium	Resource Extraction	Low	0.52 mile
	Copper		Low	
	Lead		Low	
	Zinc		Low	
Little Backbone Creek, Lower	Acid Mine Drainage	Resource Extraction	Low	0.95 mile
	Cadmium		Low	
	Copper		Low	
	Zinc		Low	

Data obtained from CWA Section 303(d).

Water Quality

Pit River

The Sacramento Valley Water Quality Coalition (SVWQC) cited several studies that have been conducted in the Pit River Subwatershed. A 1962 Pit River Water Quality Investigation by the RWQCB indicated that Pit River basin waters are suitable for agricultural purposes; waters are turbid and dark primarily because of volcanic soils and lake bottom silts; topography contributes to low DO concentrations in selected stretches of the mainstem; and flood irrigation contributes to temperature fluctuations (SVWQC 2004).

In addition to the 1962 RWQCB study, DWR produced the Pit River Water Quality Study in 1982 following the collection of field samples between spring 1977 and summer 1980 from the Pit River headwaters to Lake Britton. DO concentrations at Canby ranged between 5 and 15 milligrams per liter (mg/L), while farther downstream at Bieber and Lookout, concentrations ranged between 5.5 and 10.2 mg/L. Nitrate nitrogen ranged from 0.0 to 0.31 mg/L. Median ammonia plus organic nitrogen concentrations were 1.1 mg/L in the mainstem between Alturas and Bieber and 0.06 mg/L between Pittville and Lake Britton.

In a more recent water quality investigation conducted by the RWQCB in 2001 and 2002, the data indicate that temperature and DO criteria were being exceeded. The RWQCB collected data from eight locations between the headwaters of the Pit River and Pittville and found that 2001 and 2002 flows were far lower than the historical average. In addition, results at every station except one indicated that temperatures exceeded tolerance levels for coldwater species. In relation to the 303(d) listing, the RWQCB study recommends reevaluating historical information based on the presence or absence of coldwater species to determine the extent that controllable factors exist. Summertime DO levels in the Pit River typically ranged from 8 to 12 mg/L at mid-day, dipping to 3–5 mg/L by the early morning hours.

As discussed above, the Pit River is listed as impaired for nutrients, organic enrichment/low DO, and temperature; while the Fall River is listed as impaired for sedimentation/siltation. Sedimentation and siltation can be a result of management practices, such as timber harvesting, or a result of a catastrophic wildfire. In addition, high magnitude flows of relatively short durations may disturb and re-suspend sediment, resulting in a higher turbidity.

Water quality data from the USGS website were obtained for the Pit River at Canby. Data were available only from 1967 to 1974. Eight of the 104 (7%) temperature samples exceeded the variable Basin Plan criteria with many of the samples within 1º of the criteria. Five of the 116 (4.3%) samples exceeded the Basin Plan criteria of 7 mg/L for DO. It is very important to note that these data are very outdated and water quality for the Pit River may have changed drastically since 1974. From 1951 to 1978, pH was monitored, and of the 284 samples collected, no samples were outside the Basin Plan criteria. These data are summarized in Table 3-6 below.

Table 3-6. Water Quality Statistics for Pit River near Canby

Earliest Date	Oct-67	Aug-67
Latest Date	1-Aug	1-Aug
	Dissolved Oxygen (µg/L)	Temperature (ºF)
Count	116	104
Minimum Concentration	5.1	32.9
Average Concentration	9.7	52.4
Maximum Concentration	13	75.2
% Exceedances	4.3	7

DO and Temperature criteria based on Basin Plan.
µg/L = micrograms per liter. Source: USGS website.

McCloud River

The quality of water in the McCloud River is influenced by both natural processes (including erosion) and various land use activities. The cumulative impacts of natural hillslope erosion, roads, and timber harvesting are the greatest influence on water quality in the McCloud River. Turbidity can increase in the early to late fall when water levels drop in Lake McCloud, resulting in the delivery of sediments to the McCloud River.

The McCloud River Water Quality Monitoring Project (1986–1997) allowed for a detailed analysis of how management practices affect the suspended sediment, turbidity, temperature, and pH of the river (LMRWA 1998). The study concluded that timber harvesting activities influence the water quality of the river, resulting in statistically significant increases in the concentrations of suspended sediment. (LMRWA 1998).

The CWA Section 303(d) list does not show the McCloud River as impaired for any constituents. Water quality data from the USGS website were downloaded for the McCloud River above Lake Shasta. Data were available only from 1967 to 1980. Temperature data, and DO data were all within Basin Plan criteria. These data are summarized in Table 3-7 below.

Table 3-7. Water Quality Statistics for the McCloud River above Lake Shasta

Earliest Date	Oct-67	Oct-67
Latest Date	Sep-80	Sep-80
	Dissolved Oxygen (µg/L)	Temperature (ºF)
Count	96	98
Minimum Concentration	7.8	34.7
Average Concentration	11.2	51.3
Maximum Concentration	14	69
% Exceedances	–	–

DO and Temperature criteria based on Basin Plan.
Source: USGS website.

Upper Sacramento River

The water quality of the Upper Sacramento River is excellent. The only identified water quality issue for the Upper Sacramento River is turbidity and sedimentation. Data to support the identification of this issue were not presented, and no other water quality investigations were identified for the Upper Sacramento River. Other than Box Canyon Dam, which is used solely to create recreation opportunities, there are no diversions or agricultural uses in this watershed.

Squaw Creek/Lake Shasta/Horse Creek/ Little Backbone Creek

The overall water quality of Lake Shasta is excellent with the exception of the inflows from West Squaw Creek and Little Backbone Creek on the west side of the lake, and Horse Creek, which enters the Squaw Creek Arm in the eastern portion of the lake. The lower reaches of West Squaw Creek, Little Backbone Creek, and Horse Creek are impacted from acid mine drainage issuing from the portals of abandoned copper mines. Acid mine drainage is characterized by low pH and elevated concentrations of metals toxic to aquatic life. The metal concentrations within these watercourses are sufficiently elevated to eliminate fisheries in the lower reaches, which do contain aquatic life tolerant to metals and low pH conditions. The creeks' effects on Lake Shasta have been significantly reduced over the years by implementation of remedial activities at the abandoned mines. Historical large-scale fish kills in Lake Shasta at the mouths of the streams have been eliminated.

Sacramento River Basin— Shasta-Tehama Subwatershed

General Description

The Shasta-Tehama Subwatershed is located between the north central Coastal and the Klamath Mountain Ranges of northern California. The northern boundary of the subwatershed is defined by Shasta Dam, with a small portion of the subwatershed reaching up along the western side of Lake Shasta. To the south, the subwatershed crosses into the northern portions of Glenn and Butte Counties close to the Red Bluff Diversion Dam (RBDD). The Shasta-Tehama Subwatershed is approximately 2,953,361 acres. The Sacramento River, which runs the length of the subwatershed with a number of smaller tributaries, is the dominant water feature in this subwatershed. These tributaries include: Clear, Cow, Anderson, Battle, Antelope, Mill, Deer, Cottonwood, Reeds, Elder, Thomes, Burch, and Capay Creeks. Each drainage is well defined within the greater Shasta-Tehama Subwatershed boundary. Landowners and operators in many of these drainages retain water rights and divert surface water or use groundwater for irrigation. These tributaries receive irrigation and stormwater return flow and provide essential drainage to agricultural landowners and operators (SVWQC 2004). All tributaries located in the Shasta-Tehama Subwatershed drain naturally into the Sacramento River. (See Figure 3-5.)

The Sacramento River is impounded behind Shasta Dam, forming Lake Shasta. Water is released from Lake Shasta into the Sacramento River upstream of Keswick Dam. Keswick Dam forms Keswick Reservoir, which is considered a regulating reservoir for Shasta Dam. Keswick Reservoir is the last major water storage feature on the Sacramento River. There are two significant water diversions on the Sacramento River below Keswick Dam used for irrigated agriculture in the Shasta-Tehama Subwatershed: 1) the Anderson Cottonwood Irrigation District (ACID) diversion located in Northern Redding (near River Mile 299) and the RBDD located just south of Red Bluff at River Mile 243. The RBDD is used to divert water into the Tehama Colusa Canal (TCC) for use by the Tehama Colusa Canal Authority (TCCA) and the Corning Canal Water District (CCWD). In combination, the two entities (TCCA and CCWD) deliver water to 17 water districts representing about 300,000 acres of irrigated land in Tehama, Glenn, Colusa, and Yolo Counties along the west side of the Sacramento River. The Sacramento River flows from Keswick Reservoir through a narrow rock canyon before entering the broader floodplain of the northern Sacramento Valley near Redding. Flows in the Sacramento River are very high near the southernmost portion of the subwatershed where the river runs into the RBDD. Flows in the tributaries discussed below are mild compared to the Sacramento River. Table 3-8 shows monthly average flows from 1995 to 2004 on Clear, Cow, Mill, Deer, Cottonwood, and Elder Creeks and the Sacramento River at Red Bluff.

Clear Creek is one of the first major tributaries that drain into the Sacramento River downstream of Lake Shasta, approximately 12 miles downstream of Keswick Dam. The USGS monitors flow on Clear Creek near Igo, California.

Cow Creek is another major inflow to the Sacramento River. There are eight hydroelectric facilities and more than 190 water diversions in the Cow Creek watershed (DOI 2003).

Battle Creek sets the boundary between Shasta and Tehama Counties on the east side of the Sacramento River. Battle Creek is a highly manipulated watershed with numerous hydropower facilities and water diversions. In addition, the Coleman National Fish Hatchery, the largest Chinook salmon fish hatchery in the world, is located at the mouth of Battle Creek (DOI 2003). No recent flow record for Battle Creek is available on the USGS website, and Battle Creek flows are not included in Table 3-8. However, historical annual average Battle Creek flow below the Coleman National Fish Hatchery from 1962 to 1983 was 528 cfs.

The Antelope Creek watershed is approximately 78,720 acres in size and tends to have flashy seasonal flows. The USGS monitored flows at Antelope Creek near Red Bluff, California, (11379000) from 1949 to 1982. Because there are no recent flows on Antelope Creek data are not included in Table 3-8 below. The annual average flow during 1949 to 1982 was 150 cfs.

Mill Creek is considered a major tributary to the Sacramento River and has flows year round. Mill Creek originates from the southern slopes of Lassen Peak, and receives its stream flow from snowmelt and rainfall. Mill Creek flows remain relatively high during winter and spring, even in dry years. In lower Mill Creek, the hydrology is greatly influenced by two screened water diversions and their associated dams: the Ward (or Lower) and Upper diversion. The Los Molinos Mutual Water Company (LMMWC) operates both diversion dams. Water is usually taken in late spring through early fall between April and October (USFWS 2000). The USGS monitors flows on Mill Creek near Los Molinos (Table 3-8).

The Deer Creek watershed is approximately 133,120 acres in size and has seasonal flows. The USGS monitors flows on Deer Creek near Vina, California (11383500) (Table 3-8).

Cottonwood Creek is another major tributary to the Sacramento River in the Shasta-Tehama Subwatershed and sets the boundary on the west side of the Sacramento River between Shasta and Tehama Counties (Table 3-8).

Elder Creek's flow is greatest in the spring season when the snow melts and wanes in the early summer.

The Thomes Creek watershed is approximately 129,920 acres and contains seasonal flows. The USGS monitored flows on Thomes Creek from 1920 and stopped in 1996. Because there are no recent flows on Thomes Creek data is not included in Table 3-8 below. The annual average flow from 1920 to 1996 on Thomes Creek at Paskenta, California, (11382000) was 292 cfs. It is important to note that Thomes Creek flows are very seasonal and flashy.

Other Creeks

The Anderson Creek watershed is located in the Shasta-Tehama Subwatershed and lies just north of Cottonwood Creek. Anderson Creek drains into the Sacramento River on the west side just north of the Cottonwood Creek confluence with the Sacramento River. There are no known flow stations for the Anderson Creek watershed on either the USGS website or CDEC website. There are no known flow stations on Reeds Creek, which is also in the Shasta-Tehama Subwatershed, and hydrological information is scarce. Burch Creek and Capay Creek are located in the western portion of Tehama County. There is no USGS or CDEC flow station information for these watersheds.

Table 3-8. Monthly Average Flows in the Shasta-Tehama Subwatershed (1995–2004)

	Clear Creek near Igo			Cow Creek near Millerville			Mill Creek near Los Molinos			Deer Creek near Vina			Cottonwood Creek near Cottonwood			Elder Creek near Paskenta			Sacramento River at Red Bluff		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	190	490	1,132	645	2,286	4,625	184	646	1,592	177	847	2,326	614	2,912	8,831	7	176	1,208	6,968	22,604	56,787
Feb	211	492	1,569	723	2,220	5,491	247	614	1,069	270	862	1,800	1,170	4,254	12,140	2	109	366	8,456	28,543	68,396
Mar	186	359	797	501	1,494	4,519	310	535	1,200	368	746	2,066	852	2,907	7,092	4	104	892	8,103	23,290	55,449
Apr	167	267	578	324	920	1,926	259	460	655	252	565	1,238	509	1,311	2,496	2	38	250	7,446	12,264	24,973
May	99	215	499	129	729	2,406	276	507	830	150	469	1,057	297	947	2,425	2	31	203	10,334	14,731	22,923
Jun	66	127	172	36	304	1,336	142	389	790	102	239	651	122	494	2,082	1	8	65	12,650	14,808	21,153
Jul	58	81	150	18	90	313	110	228	510	82	141	251	67	173	495	1	4	21	13,603	15,186	16,765
Aug	53	85	151	12	50	145	93	142	226	75	112	170	60	86	178	2	3	9	10,589	12,388	15,787
Sep	51	113	227	17	53	121	89	119	163	78	105	147	53	72	122	1	3	7	7,936	9,249	11,901
Oct	128	171	210	22	86	149	88	118	153	80	110	141	61	85	140	1	5	17	5,788	7,074	8,110
Nov	128	208	282	94	411	1,307	123	177	329	117	180	390	62	259	991	2	15	31	6,115	7,766	14,090
Dec	170	326	580	226	1,315	2,473	133	393	755	124	497	1,424	153	1,238	3,645	0	48	107	6,501	13,199	23,625

Flows are in cfs.

Source: USGS website.

Land Use Patterns

Although significant differences in irrigated acres and crop types were apparent among available information sources, the relative proportions of each crop type were similar. The DWR land use data were used for the purposes of this report because they were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methodology uses aerial photos and relies on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

DWR land use data are summarized in Table 3-9. All numbers are based on the total amount of land, including irrigated land such as grain crops and non-irrigated land such as industrial. Native vegetation makes up the majority of area in the subwatershed with 88% of the total acreage. The other uses are approximately 2% or less in terms of acreage and range from water surface area to residential land use. (Figure 3-13.)

Irrigated agriculture makes up approximately 7.4% of land use for the entire Shasta-Tehama Subwatershed. The majority of irrigated agriculture consists of two crops: deciduous fruits and nuts and pastureland. Deciduous fruits and nuts account for 2.82%, while pasture accounts for 2.18%. However, it is important to note that not all pasture may be irrigated and that 2.18% may be a conservative estimate. Citrus and grain crops account for 1.42% of land use in the subwatershed. Field crops, idle, rice, vineyards, and semiagricultural make up the remaining 1.01% of land use in the subwatershed.

Table 3-9. Land Use Acreage for the Shasta-Tehama Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	20,728	0.71
Deciduous Fruits and Nuts	82,427	2.82
Field Crops	10,020	0.34
Grain and Hay	20,836	0.71
Idle	12,256	0.42
Pasture	63,648	2.18
Rice	2,746	0.09
Semiagricultural and Incidental	4,502	0.15
Truck, Nursery, and Berry Crops	1,502	0.05
Vineyards	189	0.01
Subtotal	218,854	7.48
Urban		
Urban—unclassified	18,177	0.62
Urban Landscape	1,438	0.05
Urban Residential	66,799	2.28
Commercial	3,280	0.11
Industrial	5,617	0.19
Vacant	8,979	0.31
Subtotal	104,290	3.56
Native		
Native Vegetation	2,586,054	88.41
Barren and Wasteland	7,608	0.26
Riparian Vegetation	18,089	0.62
Water Surface	18,602	0.64
Subtotal	2,630,353	89.93
Total	**2,925,162**	**100.00**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Shasta-Tehama Subwatershed. Table 3-10 lists the beneficial uses of Clear, Cow, Battle, Cottonwood, Mill, Deer, and Thomes Creeks.

Table 3-10. Beneficial Uses by River Sub-Areas (Basin Plan)

Beneficial Uses	Clear Creek	Cow Creek	Battle Creek	Cottonwood Creek	Mill Creek	Deer Creek	Thomes Creek
Municipal & Domestic	E	P		E	E	E	
Irrigation	E	E	E	E	E	E	E
Stock Watering	E	E	E	E	E	E	E
Process				P			
Service Supply				P			
POW (Power)		E	E	P			P
Rec-1	E	E	E	E	E	E	E
Rec-2	E	E	E	E		E	E
Freshwater Habitat—Warm	E		E	E	E	E	E
Freshwater Habitat—Cold	E	E	E	E	E	E	E
Migration—Warm							
Migration—Cold	E	E	E	E	E	E	E
Spawning—Warm	E	E	E	E	E	E	E
Spawning—Cold	E	E	E	E	E	E	E
Wildlife Habitat	E	E	E	E	E	E	E
Navigation							

P = Potential, E = Existing, U = Undefined.
Rec-1 is contact and canoeing or rafting, and Rec-2 non-contact.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Shasta-Tehama County Subwatershed includes many creeks and small tributaries to the Sacramento River. Data were acquired from a list that was last updated by the EPA in July 2003. Identified sources of impairment in the Sacramento River are agricultural and resource extraction (mining). (Table 3-11.)

According to the CWA Section 303(d) list of water quality–impaired rivers, Cow Creek is impaired for fecal coliform.

CWA Section 303(d) establishes the TMDL process to assist in guiding the application of state water quality standards, requiring the states to identify streams in which water quality is impaired (affected by the presence of pollutants or contaminants) and to establish the TMDL or the maximum quantity of a particular contaminant that a water body can assimilate without experiencing adverse effects.

The 303(d) list breaks up the Sacramento River into four sections—Keswick Dam to Cottonwood Creek, Cottonwood Creek to Red Bluff, Red Bluff to Knights Landing, and Knights Landing to the Sacramento–San Joaquin River Delta (Delta). All sections of the Sacramento River are listed on the 303(d) list for unknown toxicity, and Knights Landing to the Delta is also listed for diazinon and mercury. Mercury is primarily a legacy of gold mining; and diazinon, a pesticide, is primarily from agricultural and urban application, although urban use of diazinon should be on the decline as the nonagricultural unrestricted use of diazinon has been phased out by the EPA.

Table 3-11. Impaired Status by River Sub-Areas

Watershed/Subwatershed	Pollutant	Potential Sources	TMDL Priority	Estimated Size Affected
Clover Creek	Fecal coliform	Agriculture-grazing, other	Low	11 miles
Little Cow Creek	Cadmium	Resource extraction (abandoned mines)	Low	1.1 miles
	Copper	Resource extraction (abandoned mines)	Low	1.1 miles
	Zinc	Resource extraction (abandoned mines)	Low	1.1 miles
Sac River (Keswick Dam to Cottonwood Creek)	Unknown toxicity	Source unknown	Low	15 miles
Sac River (Cottonwood Creek to Red Bluff)	Unknown toxicity	Source unknown	Low	16 miles
Sac River (Red Bluff to Knights Landing)	Unknown toxicity	Source unknown	Low	82 miles
Sac River (Knights Landing to the Delta)	Diazinon	Agriculture	High	16 miles
	Mercury	Resource extraction (abandoned mines)	Medium	16 miles
	Unknown toxicity	Source unknown	Low	16 miles

Source: CWA Section 303(d), from RWQCB web site or Geo WBS GIS.

Water Quality

Reported water quality throughout the Shasta-Tehama Subwatershed is of good to excellent quality. Water management operations at Shasta Dam and other flow-regulating facilities substantially influence the flow regime of the Sacramento River. Water quality dynamics also have been influenced by operation of these flow-regulating facilities. DO is a critical component for all forms of aquatic life. The Basin Plan specifies a DO objective of 9.0 mg/L from June 1 to August 31 for the Sacramento River from Keswick to Hamilton City. (Central Valley Water Board 1998.) DO concentrations in the Sacramento River are typically higher than the Basin Plan objective and are not considered a problem for the entire Sacramento River. EC is a measure of the degree to which a given water sample conducts an electrical current. The amount of total dissolved solids (TDS) in water is directly related to EC; that is, high EC is an indicator of high TDS. TDS and EC are general indicators of salinity. Basin plan criteria for EC on the Sacramento River are 700 microsiemens per centimeter (µS/cm). Typical EC data for the Sacramento River within the Shasta-Tehama Subwatershed are under the Basin Plan criteria. A 5-year historical USGS dataset from the Sacramento River at Hamilton City station shows the EC levels all to be under 200 µS/cm. The minimum concentration was 82 µS/cm, the average concentration was 128 µS/cm, and the maximum concentration was 174 µS/cm**.**

Water temperature is a critical constituent from the standpoint of aquatic life. For the Sacramento River, from its source to Box Canyon Reservoir, Sacramento River from Box Canyon Dam to Shasta Lake, the following applies:

- From December 1 to March 15, the maximum temperature shall be 55ºF.
- From March 16 to April 15, the maximum temperature shall be 60ºF.
- From April 16 to May 15, the maximum temperature shall be 65ºF.
- From May 16 to October 15, the maximum temperature shall be 70ºF.
- From October 16 to November 15, the maximum temperature shall be 65ºF.
- From November 16 to November 30, the maximum temperature shall be 60ºF.

For Lake Siskiyou, the epilimnion shall be less than or equal to 75ºF or mean daily ambient air temperature, whichever is greater. For the Sacramento River from Shasta Dam to I Street Bridge, the temperature shall not be elevated above 56ºF in the reach from Keswick Dam to Hamilton City nor above 68ºF in the reach from Hamilton City to the I Street Bridge during periods when temperature increases will be detrimental to the fishery.

Like DO, the Sacramento River water temperature rarely rises above or drops below the Basin Plan standard. Another important parameter pertaining to water quality is pH. pH is reported on a scale from 0 to 14. If a solution measures less than 7 on the pH scale, it is acidic. If a solution measures greater than 7 on the pH scale it is basic, or alkaline, and if a solution measures 7 it is neutral. The Basin Plan objective for pH requires that the pH not be depressed below 6.5 nor raised above 8.5. Further more, changes in pH shall not exceed 0.5. For Goose Lake, pH shall be less than 9.5 and greater than 7.5 at all times. Like temperature and DO, the Sacramento River pH is very rarely below or above Basin Plan criteria and needs no further evaluation.

Some elevated levels of trace metals such as copper and iron are present in the Sacramento River as a result of drainage from acid mine wastes originating from the Iron Mountain mine primarily and from other sources on the Sacramento River. Many metals found in water can be toxic to aquatic life at elevated concentrations. Table 3-12 summarizes Sacramento River water conditions for three metals near the city of Chico. Maximum concentrations of all three metals are below the drinking water criteria.

In addition, the Sacramento River Basin is listed as impaired for mercury under the Clean Water Act Section 303(d). For more information regarding Section 303(d), refer to the impaired status section. More information about mercury can also be obtained from the Sacramento–San Joaquin Delta Methylmercury TMDL (Central Valley Water Board 2005b). Table 3-12 also contains mercury data from the Sacramento River at Hamilton City. The human health criteria for mercury are 0.05 µg/L. All concentrations in Table 3-12 are below the human health criteria. The total count of the data set is only from 5 samples.

Table 3-12. Receiving Water Concentrations for Copper, Lead, and Zinc and Respective Water Quality Criteria

Metal	Maximum	Average	Minimum	CTR Criteria CMC [a]	CTR Criteria CCC [a]	Basin Plan Objectives[b]
Copper	3.3	2.5	ND	6.3	4.5	0.0056 mg/L
Lead	0.68	0.26	ND	27	1	
Zinc	10	6.5	ND	60	60	0.016 mg/L[c]
Mercury	0.01079	0.0035	0.00087	0.05	N/A	N/A

ND = non-detect.
CCC = criteria continuous concentration (chronic regulatory standard).
CMC = criterion maximum concentration (acute regulatory standard).
CTR = California Toxics Rule.

[a] These criteria are based on a hardness of 45 mg/L as $CaCO_3$. The lowest measured river hardness is 46 mg/L as $CaCO_3$.

[b] For the Sacramento River and its tributaries above the State Highway 32 Bridge at Hamilton City.

[c] This criteria is based on a hardness of 40 mg/L as $CaCO_3$.

Average values are arithmetic mean of all values above ND. The Mercury Criteria is the EPA Human Health Criteria. The EPA has established a tissue residue criterion of 0.3 mg methylmercury/kg fish (EPA 2001).

Source: Data compiled in Flow Science 2004. Mercury data obtained through personal communication via email with the Central Valley Water Board (Murano 2004)

Sacramento River Basin Watershed—Upper Feather River–Upper Yuba River Subwatershed

General Description

The Upper Feather–Upper Yuba Subwatershed is located in the mountainous region of three counties in northern California. The watershed spans the counties of Plumas, Sierra, and Nevada. To the north lie Shasta, Tehama, and Lassen Counties. To the south is Placer County, to the west lie Tehama and Butte Counties, and to the east is Lassen County. Figure 3-6 shows the Upper Feather River–Upper Yuba River Subwatershed.

Precipitation in this watershed ranges from 69.7 inches in the west to less than 12.2 inches in the east. This difference can be attributed to storm systems from the Central Valley, which move west to east and deposit the majority of their precipitation along the west slope of the Sierra Nevada Mountains (SVWQC 2004).

Upper Feather River

The Feather River watershed includes 2,062,080 acres of land that drains west from the northern Sierra Nevada Mountains into the Sacramento River. This water body is considered unique because the North and Middle Forks originate east of the Sierra Nevada Mountains in the Diamond Mountains, and as these two forks flow west, they breach the crest of the Sierra Nevada Mountains on their way to Lake Oroville (SVWQC 2004).

The Upper Feather River watershed is located primarily in Plumas County, with a portion of the Middle Fork draining the Sierra Valley, which is located in Sierra County. Plumas County contains 29,472 irrigated acres, including 18,223 acres of pastureland. Sierra County contains 10,012 irrigated acres, including 8,648 acres of pastureland.

The Middle Fork of the Upper Feather River receives flow from Dolly Creek and Little Grizzly Creek. The USGS website does not have flow data for Dolly Creek but does contain flow data for Little Grizzly Creek from 1964 to 1979. Because there are only historical data, annual average data were calculated instead of the monthly average data. The annual average flow from 1964 to 1979 for Little Grizzly Creek was 48 cfs. The USGS website does not contain flow data for any of the upper arms of the Feather River.

Upper Yuba River

The North Fork of the Upper Yuba River feeds New Bullards Bar Reservoir. The Middle Fork and the South Fork of the Yuba River flow together prior to Englebright Reservoir, which is a small reservoir downstream of New Bullards Bar Reservoir. However, Englebright Reservoir is part of the Butte-Sutter-Yuba Subwatershed and discussed in detail in that section. The CDEC website monitors flow on the North Fork Yuba, the Middle Fork Yuba, and the South Fork Yuba. The North Fork Yuba River flows are below the New Bullards Bar Dam release. The Middle Fork Yuba River flows are measured just before the confluence with the North Fork Yuba River at Our House Dam. South Fork Yuba River flows together with the North and Middle Fork Yuba River and flows are measured at Jones Bar. The South Yuba River contains two 303(d)-listed tributaries, Humbug Creek, and Kanaka Creek. In addition, the South Yuba River also has Deer Creek as a tributary, which is impaired for pH. The USGS website and the CDEC website do not show any flow stations on either of these tributaries. For more information on the 303(d)-listed water bodies, refer to the Impaired Status section. Flows are shown in Table 3-13 below.

Upper Bear River

Bear River originates in the vicinity of Emigrant Gap and Lake Spaulding in the Sierra Nevada foothills and flows southwest to intersect the Feather River upstream of the city of Nicolaus. The entire Bear River drainage area is 352,000 acres (MBK Engineers and Flood Control Study Team 2002). There are three reservoirs on the Bear River: Rollins Reservoir, Lake Combie, and Camp Far West Reservoir. The Upper Feather River Subwatershed border is approximately at the Camp Far West Reservoir Dam release, and everything below is in the Butte-Sutter-Yuba Subwatershed.

Table 3-13. Table of Flows for Upper Feather River–Upper Yuba River Subwatershed

	Feather River at Oroville			North Yuba River below New Bullards Bar Dam			Middle Yuba River below Our House Dam			South Yuba River at Jones Bar			Bear River below Camp Far West Reservoir		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	618	3,338	26,748	10	18	38	31	64	144	93	447	838	12	14	22
Feb	619	2,312	7,477	34	322	1,002	36	157	531	219	738	1,657	11	14	19
Mar	617	2,684	18,873	16	475	786	32	50	65	197	531	851	11	14	22
Apr	615	813	2,490	9	328	1,227	43	47	49	220	446	721	24	27	32
May	620	1,481	7,916	9	19	37	53	64	104	112	611	1,323	26	28	30
Jun	617	634	668	30	98	224	42	47	58	52	602	2,281	26	27	30
Jul	621	658	718	11	33	56	29	33	36	43	93	284	10	11	13
Aug	618	665	799	9	20	47	22	30	36	33	48	74	10	11	13
Sep	623	636	659	9	14	20	22	28	35	14	34	53	10	11	13
Oct	627	807	1,580	8	14	26	22	28	33	34	50	70	11	13	14
Nov	626	884	1,633	9	48	94	30	32	34	62	102	181	12	13	18
Dec	620	1,337	5,764	8	28	85	34	64	153	72	307	586	12	14	16

Flows are in cfs and monthly average flows 1995–2004, except North Fork River flows are 1998–2001 and Middle Fork Yuba River flows are 2000–2004.

Source: USGS website.

Land Use Patterns

Although significant differences in irrigated acres and crop types were apparent among available information sources, the relative proportions of each crop type were similar. The DWR land use data were used for the purposes of this report because DWR was the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

The majority of land use in the Upper Feather River Subwatershed is classified as native vegetation, which makes up approximately 94% of the acreage. The surrounding area is relatively rural, and urbanization is minimal making just over 1% of the Subwatershed. Total irrigated agriculture is classified as deciduous fruits and nuts, grain/hay crops, pasture, rice, semiagriculture, truck, nursery and berry crops, and agriculture. See Table 3-14 for individual acreages. Combined, irrigated agriculture makes up only a small portion of the Upper Feather River Subwatershed totaling only 2.4% of land use. Figure 3-14 shows land use for the entire Subwatershed as delineated by the DWR land use database. Clearly the Upper Feather River Subwatershed does not contain much irrigated agriculture. In addition, the 2.4% of irrigated agriculture may be a very conservative value based on the fact that pasture (the largest portion classified in this category) may or may not be irrigated land.

Table 3-14. Land Use Acreage according to DWR and FRAP Land Use Data for the Upper Feather River–Upper Yuba River Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	58	0.002
Grain and Hay Crops	2,044	0.067
Idle	1,330	0.044
Pasture	64,100	2.113
Rice	7	0.0002
Semiagricultural and Incidental	785	0.026
Truck, Nursery, and Berry Crops	468	0.015
Subtotal	68,790	2.268
Urban		
Urban—unclassified	2,333	0.077
Urban Residential	10,121	0.334
Urban Landscape	939	0.031
Commercial	2,445	0.081
Industrial	1,427	0.047
Vacant	1,114	0.037
Subtotal	18,380	0.606

DWR Land Use Type	Acres	Percent Total
Native		
Native Vegetation	2,368,492	78.076
Barren and Wasteland	230	0.008
Riparian Vegetation	29,379	0.968
Water Surface	53,776	1.773
Subtotal	2,451,877	80.824
FRAP Land Use Type		
Agriculture	5,082	0.168
Barren	19,716	0.650
Conifer	275,875	9.094
Hardwood	115,684	3.813
Herbaceous	26,702	0.880
Shrub	24,213	0.798
Urban	18,017	0.594
Water	7,512	0.248
Wetland	1,734	0.057
Subtotal	494,534	16.302
Total	**3,033,583**	**100**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Upper Feather River–Upper Yuba River Subwatershed. Table 3-15 lists the beneficial uses for the North Fork Feather River, Middle Fork Feather River to Little Last Chance Creek, Middle Fork Feather River to Frenchman Reservoir, Yuba River to Englebright Reservoir, Yuba River—Englebright Dam to Feather River, and Bear River.

Table 3-15. Beneficial Uses by River Sub-Areas

Beneficial Uses	North Fork Feather River	Middle Fork Feather River to Little Last Chance Creek	Middle Fork Feather River to Frenchman Reservoir	Yuba River to Englebright Reservoir	Yuba River—Englebright Dam to Feather River	Bear River
Municipal & Domestic	E			E		E
Irrigation		E		E	E	E
Stock Watering		E		E	E	E
Process						
Service Supply					E	
POW (Power)	E			E	E	E
Rec-1	E, E	E, E	E	E, E	E, E	E
Rec-2	E	E	E	E	E	E
Freshwater Habitat—Warm		E	P		E	E
Freshwater Habitat—Cold	E	E	E	E	E	E
Migration—Warm					E	P
Migration—Cold					E	P
Spawning—Warm					E	P
Spawning—Cold	E	E	E	E	E	E
Wildlife Habitat	E	E	E	E	E	
Navigation						

P = Potential, E = Existing, U = Undefined.
Rec-1 is contact and canoeing or rafting, and Rec-2 noncontact.
Source: Sacramento–San Joaquin River Basin Plan or RWQCB web site.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list.

According to the CWA Section 303(d) list of water quality–impaired rivers, the Upper Feather–Upper Yuba River Yuba Subwatershed is impaired for multiple pollutants. The majority of the problems are thought to come from resource extraction such as abandoned mines. Table 3-16 shows the 303(d)-listed status for sub-areas.

Table 3-16. Impaired Status by River Sub-Areas

Watershed/Subwatershed	Pollutant	Potential Sources	TMDL Priority	Estimated Affected Size
Little Grizzly Creek	Copper	Resource extraction	Medium	9.4 miles
	Zinc		Medium	
Dolly Creek	Copper	Resource extraction	Low	1.5 miles
	Zinc		Low	
Kanaka Creek	Arsenic	Resource extraction	Low	9.7 miles
French Ravine	Bacteria	Land disposal	Low	1.7 miles
Combie Lake	Mercury	Resource extraction	Medium	362 acres
Camp Far West Reservoir	Mercury	Resource extraction	Medium	1945 acres
Upper Bear River	Mercury	Resource extraction	Medium	10 miles
Deer Creek (Yuba County)	pH	Internal nutrient cycling	Low	4.3 miles
Humbug Creek	Copper	Resource extraction	Low	2.2 miles
	Mercury	Resource extraction	Low	
	Sedimentation/ Siltation	Resource extraction	Low	
	Zinc	Resource extraction	Low	

Data obtained from 2002 CWA Section 303(d) List of Water Quality Limited Segments.

Water Quality

The water quality impacts of concern for the Feather River are sedimentation, increased water temperatures from the loss of riparian shade canopy and the progressive widening and shallowing of the stream channels, and loss of the water holding capacity of the watershed (in the extensive meadow systems) as a result of stream channel incisement (State Water Board).

According to the State Water Board, existing conditions in the watershed are a result of five major historical and current land uses. They are (1) mining; (2) wildfire; (3) livestock grazing; (4) timber harvest, with its associated roads, skid trails and log landings; and (5) railroad and highway construction and maintenance. A North Fork Feather River recent survey found that at least 60% of the watershed has been degraded. The resulting impact includes decreased soil productivity, lowered water quality, greatly reduced riparian plant and wildlife communities, lowered water tables, and frequent damaging floodflows.

The State Water Board researched quality problems in this watershed. Based on this research, a preliminary estimate is that up to 50% of all stream channels are in a degraded condition. In addition, wetlands, meadows, and rangelands are at risk of being degraded to a serious level. An estimated loss of 6–12 inches of topsoil from meadows and upland areas as a result of human-related disturbance activities has contributed to the formation of numerous large and small gullies.

Annually, 1.1 million tons of sediment are delivered to Rock Creek Dam at the downstream end of the North Fork Feather River Watershed; an estimated 80% of this yearly sediment yield is from "accelerated," human-caused erosion in the watershed. Federal and state water quality criteria for 303(d) listed compounds are shown in Table 3-17 below.

Table 3-17. Water Quality Criteria

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)		
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL or DWEL	CDHS	CTR
Arsenic	N/A	N/A	150	340	10	50	N/A
Mercury (total)	N/A	N/A	0.77	1.4	2.0 (inorganic)	2.0 (inorganic)	0.05
Copper	–	–	–	–	N/A	1,300	1,300
Zinc	–	–	–	–	2,000	5,000	–

CDHS = California Department of Health Services.

SNARL = suggested no adverse response levels for non-cancer toxicity. (Mercury SNARL concentration is total.)

DWEL = Drinking Water Equivalent Level.

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. DHS criteria for copper are the primary maximum contaminant level (MCL). CTR chronic and acute criteria are equal to EPA criteria. The EPA has established a fish tissue residue criterion of 0.3 mg methylmercury/kg fish (EPA 2001).

Sources: EPA 2003; Siepman and Finlayson 2000.

The USGS website has virtually no water quality data for locations within the Upper Feather–Upper Yuba Subwatershed but does show data for the Upper Bear River below Rollins Reservoir near Colfax. CWA Section 303(d) List states that the Upper Bear River is impaired for mercury. Five mercury samples were collected in 2003 at Bear River below Rollins Reservoir and seven samples were collected at Bear River below Camp Far West Reservoir, and no samples exceeded the CTR criteria of 0.05 µg/L. Results are shown in Table 3-18 below. None of the remaining 303(d) listed areas in the Upper Feather–Upper Yuba River Subwatershed is available on the USGS website for water quality.

Table 3-18. Total Mercury Data for Bear River

	Mercury (µg/L)	
	Bear River Below Rollins Reservoir	Bear River Below Camp Far West Reservoir
Earliest Date	Jan-03	Jan-03
Latest Date	Oct-03	Jul-06
Count	5	7
Minimum Concentration	0.0015	0.002
Average Concentration	0.008	0.006
Maximum Concentration	0.021	0.023
% Exceedances	0	0

Source: USGS website.

Sacramento River Basin—Colusa Basin Subwatershed

General Description

The Colusa Basin Subwatershed is located in Glenn and Colusa Counties, as well as portions of northern Yolo County to Cache Creek. To the north is Tehama County, and Cache Creek makes up the southern border. The Sacramento River makes up the eastern border and Lake and Mendocino Counties are on the west. The Colusa Basin Subwatershed is approximately 1,655,846 acres. (Figure 3-7.)

The eastern two-thirds of the subwatershed is located in the Great Valley geomorphic province, and the western third is located in the Coast Range province. The northern one-third of the Great Valley is drained by the Sacramento River. The annual precipitation for this basin ranges between 16 and 24 inches, with most rainfall occurring during the winter and early spring seasons (SVWQC 2004).

Generally during the summer months, soils are hot and dry; in the winter they are cold and wet. Because of the climate characteristics, Aquic soils moisture regimes are found in the Colusa Basin. These soils, which occur along streams and in marshes, support hydrophytic vegetation because the soils are moisture-saturated and free of DO during part of the year. The Great Valley contains alluvial basin, old terraces, and floodplains of the Sacramento River. The area has intensively cultivated croplands, marshes, and river floodplains. The poorly drained soils in the Colusa Basin Subwatershed make the area ideal for rice production.

Sacramento River

The Sacramento River is the major waterway in the Colusa Basin Subwatershed and makes up almost the entire eastern border of the subwatershed. Its drainage area encompasses approximately 27,200 square miles (DWR 2003). Water management operations of the Central Valley Project (CVP) dams, operated by the Bureau of Reclamation, are primarily responsible for determining flow levels in the river. Lake Shasta, upstream of the project area, is the largest storage reservoir in the CVP, with a usable capacity of 4.4 maf. The Sacramento River and other flood control facilities located on the upper river and its tributaries attenuate high flows in the mainstem of the Sacramento River. As a result, the smaller tributaries (which are unregulated or have limited storage capacity) contribute a substantial portion of the seasonally high flows. The USGS website contained flow data for the Sacramento River at Verona, which is just downstream of the Feather River confluence. The nearest flow record upstream of the Verona location that is a more representative flow record for the Colusa Basin Subwatershed is an incomplete record. Monthly average flows from 1995 to 2004 are included in Table 3-19.

Cache Creek

Cache Creek makes up the southern boundary of the Colusa Basin Subwatershed. The Cache Creek watershed drains into Clear Lake and drains out of Clear Lake down into the Central Valley until it meets the Sacramento River. This section covers the lower portion of Cache Creek. The upper portion of Cache Creek is discussed in detail in the Lake County section. The USGS website contained flow data for Cache Creek at Yolo. Monthly average flows from 1995 to 2004 are included in Table 3-19.

Colusa Basin Drain

Colusa Drain starts east of the town of Willows and runs west of the Sacramento River to Knights Landing, draining 230,000 acres. Construction on the canal began in the 1920s during a boom in rice production and ended in the 1940s, providing drainage for agriculture (predominantly rice). Herbicides used in rice production have caused water quality concerns related to the drain. (Sacramento River Watershed Program 2005.) The USGS website and CDEC website contain no flow data for the Colusa Basin Drain.

Bear Creek/Harley Gulch

Bear Creek stretches 39 miles from its headwaters to its confluence with Cache Creek, about midway through the Cache Creek Canyon. The Bear Creek watershed is sparsely populated. Much of the Bear Creek watershed, including Bear Valley, is rangeland. The lower portion of the watershed is rugged and lies within the Bureau of Land Management Cache Creek management area. There are no dams in Bear Creek. Analysis of USGS data determined that flows near Rumsey are highest in the late winter to early spring season (December to May), and very low in the summer and fall (June to November). Harley Gulch drains into Bear Creek prior to Bear Creek’s confluence with Cache Creek. Harley Gulch is a very small tributary. The USGS website contained flows for Bear Creek near Rumsey and Harley Gulch near Wibur Springs. Monthly average flows from 1995 to 2004 are included in Table 3-19.

Sulphur Creek

Sulphur Creek flows southeast from its headwaters at Indian Valley Reservoir to Bear Creek. It connects just east of the town of Wilbur Springs and flows through part of the Sulphur Creek mining district. USGS flow data from the station above Holsten Chimney near Rumsey indicate that the flow is seasonal, with the highest flows from December to March, but remains low throughout the year. The USGS website contained flow data for Sulphur Creek near Wibur Springs. Monthly average flows from 1995 to 2004 are included in Table 3-19.

Stony Creek/Black Butte Reservoir

Stony Creek drains out of Black Butte Reservoir and makes up the northeastern boundary of the Colusa Basin Subwatershed until its confluence with the Sacramento River near Orland, California. The USGS website contains no recent flow data for Stony Creek; therefore, the monthly average flows were not calculated. The minimum flow at Stony Creek between 1980 and 1990 was 0 cfs, the average flow was 571 cfs, and the maximum flow was 22,900 cfs. The Black Butte Reservoir storage capacity is 136,000 acre-feet. The Stony Creek inflow to Black Butte Reservoir is the primary inflow. The secondary inflow is Bedford Creek; however, no flow data are available for this location.

Davis Creek Reservoir

Davis Creek Reservoir was constructed in 1984 to provide water for gold processing. While its predicted average volume of inflow is 5,050 acre-feet per year, its full capacity is 6,000 acre-feet, covering nearly 198 acres with a maximum depth of 82 feet. Installation of water recycling technology has allowed the water level to stabilize. Upstream of the reservoir are the abandoned Reed and Harrison mercury mines, which have caused the reservoir to be impaired for mercury (UC Davis 2005).

Table 3-19. Monthly Average Flows on the Sacramento River and, Cache Creek from 1995 to 2004, Bear Creek from 1997 to 2004, Sulphur Creek from 1999 to 2004, and for Harley Gulch from 2000 to 2004

	Sacramento River at Verona			Cache Creek at Yolo			Bear Creek above Holsten Chimney near Rumsey			Sulphur Creek at Wilbur Springs			Harley Gulch near Wilbur Springs		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	15,416	37,717	71,035	81	2,322	7,177	14	104	252	3	9	17	0.27	1.02	2.32
Feb	16,034	44,100	69,817	181	3,081	12,617	35	287	1,029	3	14	35	0.34	2.79	7.25
Mar	17,752	38,249	62,248	108	2,391	7,003	21	103	180	2	7	13	0.23	1.19	1.95
Apr	10,397	24,617	52,577	23	796	2,843	10	45	126	1	2	4	0.16	0.30	0.41
May	7,802	22,375	49,810	15	267	812	5	31	124	1	1	3	0.07	0.13	0.23
Jun	10,532	18,907	44,507	5	73	418	3	13	57	0	0	1	0.02	0.03	0.05
Jul	13,384	18,024	21,681	3	38	141	1	4	14	0	0	0	0.00	0.01	0.02
Aug	12,132	16,525	21,255	3	38	139	1	2	6	0	0	0	0.00	0.01	0.02
Sep	11,175	14,593	20,997	2	37	106	1	2	5	0	0	0	0.00	0.01	0.02
Oct	7,360	9,809	12,881	1	40	73	1	3	5	0	0	0	0.00	0.02	0.07
Nov	10,201	11,923	18,437	5	41	82	3	12	32	0	1	4	0.02	0.21	0.52
Dec	11,658	25,271	44,855	17	537	1,622	3	103	259	1	13	26	0.14	3.28	6.90

Land Use Patterns

Although significant differences in irrigated acres and crop types were apparent among available information sources, the relative proportions of each crop type were similar. The DWR land use data were used for the purposes of this report because DWR was the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Table 3-20 shows the DWR land use data for the Colusa Basin. The majority of land use in the Colusa Basin Subwatershed is classified as native vegetation, which makes up approximately 60% of the acreage. The surrounding area is relatively rural, and urbanization is minimal, making up less than 1% of the subwatershed. Total irrigated agriculture is classified as citrus and subtropical, deciduous fruits and nuts, field crops, grain/hay crops, pasture, rice, semiagriculture, truck, nursery and berry crops, and vineyards. Combined, irrigated agriculture makes up 36% of the acreage, making it the second largest land use type in the subwatershed. Figure 3-15 shows land use for the entire subwatershed as delineated by the DWR land use database. In addition, the 36% of irrigated agriculture may be a very conservative value based on the fact that pasture (occupying 48,113.72 acres) may or may not be irrigated land.

Table 3-20. Land Use Acreage according to DWR Land Use Data for the Colusa Basin

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	5,601	0.34
Deciduous Fruits and Nuts	77,535	4.68
Field Crops	80,851	4.88
Grain and Hay	78,068	4.71
Idle	17,509	1.06
Pasture	48,114	2.91
Rice	216,299	13.06
Semiagricultural and Incidental	6,583	0.40
Truck, Nursery, and Berry Crops	68,940	4.16
Vineyards	6,403	0.39
Subtotal	605,903	36.59
Urban		
Urban—unclassified	2,819	0.17
Urban Landscape	523	0.03
Urban Residential	5,477	0.33
Commercial	887	0.05
Industrial	3,644	0.22

DWR Land Use Type	Acres	Percent Total
Vacant	12,440	0.75
Subtotal	25,790	1.55
Native		
Barren and Wasteland	4,651	0.28
Native Vegetation	958,908	57.91
Riparian Vegetation	38,239	2.31
Water Surface	22,405	1.35
Subtotal	1,024,203	61.85
Total	**1,655,896**	**100**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Colusa Basin Subwatershed. Table 3-21 lists the beneficial uses of the Colusa Basin Drain and Stony Creek.

Table 3-21. Beneficial Uses by River Sub-Areas

Beneficial Use	Colusa Basin Drain	Stony Creek
Municipal & Domestic		
Irrigation	E	E
Stock Watering		E
Process		
Service Supply		
POW (Power)		
Rec-1	E	E
Rec-2		E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	P	P
Migration—Warm	E	
Migration—Cold		E
Spawning—Warm	E	E
Spawning—Cold		E
Wildlife Habitat	E	E
Navigation		

P = Potential, E = Existing, U = Undefined.
Rec-1 is contact and canoeing or rafting, and Rec-2 noncontact.
Source: Sacramento–San Joaquin River Basin Plan or RWQCB web site

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Colusa Basin Drain is listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003.

According to the CWA Section 303(d) list of water quality–impaired rivers, the Colusa Basin Drain is impaired for azinphos-methyl, cabofuran/furadan, diazinon, Group A pesticides, malathion, methyl parathion, molinate/odram, and unknown toxicity. Potential sources of these impairments are considered to be agriculture and agriculture-irrigation tail water. TMDL priority status in the Colusa Basin Drain ranges from low to medium. Table 3-22 shows the priority status for each pollutant by subwatershed.

The Sacramento River from Red Bluff to Knights Landing is impaired for unknown toxicity with a low TMDL priority (Table 3-22). However, immediately downstream from Knights Landing, the Sacramento River is impaired for diazinon, mercury, and unknown toxicity. See the Solano-Yolo Subwatershed section for more information on this impairment. The Central Valley Water Board has developed the Sacramento and Feather Rivers Diazinon TMDL. This TMDL contains information about diazinon loads within the rivers.

Lower Cache Creek, which runs form Clear Lake Dam to Cache Creek Settling Basin near the Yolo Bypass, is impaired for mercury. Sulphur Creek, Bear Creek, and Harley Gulch are also impaired for mercury. The Central Valley Water Board has developed and adopted the Cache Creek Mercury TMDL wich includes Sulphur Creek, Bear Creek and Harley Gulch. The TMDL is pending approval from the State Board, Office of Administrative Law, and the EPA.These impairments are caused by resource extraction, specifically abandoned mines. Davis Creek Reservoir is impaired for mercury. Resource extraction is the identified potential source, and the impairment has low TMDL priority.

Table 3-22. Impaired Status by River Sub-Areas

Watershed/Subwatershed	Pollutant	Potential Source	TMDL Priority	Estimated Size Affected
Colusa Basin Drain	Azinphos-methyl	Agriculture	Medium	49 miles
	Carbofuran/Furadan	Agriculture	Low	49 miles
	Diazinon	Agriculture	Medium	49 miles
	Group A Pesticides	Agriculture	Low	49 miles
	Malathion	Agriculture	Low	49 miles
	Methyl Parathion	Agriculture	Low	49 miles
	Molinate/Odram	Agriculture-irrigation tailwater	Low	49 miles
	Unknown Toxicity	Agriculture	Low	49 miles
Sacramento River (Red Bluff to Knights Landing)	Unknown Toxicity	Source Unknown	Low	82 miles
Lower Cache Creek (Clear Lake Dam to Cache Creek Settling Basin near Yolo Bypass)	Mercury	Resource Extraction (abandoned mines)	Medium	96 miles
	Unknown Toxicity	Source Unknown	Low	96 miles
Bear Creek	Mercury	Resource Extraction	Medium	15 miles
Sulphur Creek	Mercury	Resource Extraction (abandoned mines)	Medium	14 miles
Harley Gulch	Mercury	Resource Extraction (abandoned mines)	Medium	6 miles
Davis Creek Reservoir	Mercury	Resource Extraction	Low	163 acres

Data obtained from CWA Section 303(d)
Source: RWQCB web site or Geo WBS GIS.

Water Quality

Agriculture and resource extraction are the two activities/land uses that cause the greatest detriment to water quality in this subwatershed. Colusa Basin Drain is impaired for a number of organophosphates and other agricultural pesticides (azinphos-methyl, diazinon, etc) that are of particular concern in biological systems and waterways. The EPA deems such pesticides substances with acute toxicity, and many have been discontinued in recent years. Although these pesticides often dissipate very quickly in water, they break down chemically to other readily absorbable toxic substances. Organophosphate insecticides are used agriculturally and can be applied with aerial equipment, an airblast sprayer (microencapsulated formulation only), by chemigation (microencapsulated formulation only), and with groundboom equipment (EPA) and can seep into the groundwater or dissipate into runoff during the rainy season or through irrigation. Table 3-23 (below) shows the various state and federal criteria for the pollutants contained in on the CWA Section 303(d) list for this subwatershed.

Table 3-23. State and Federal Criteria

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)		
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL1	CDHS	CTR
Diazinon	0.05	0.08	0.1	0.1	0.6001	6	N/A
Dieldrin (Group A Pesticides)	N/A	N/A	0.056	0.24	0.5	0.002	0.00014
Mercury (total)	N/A	N/A	0.77 (total)	1.4 (total)	2.0 (inorganic)	N/A	0.05 (total)
Carbofuran	N/A	N/A	N/A	0.5*	40	18	N/A
Azinphos-methyl	N/A	N/A	N/A	0.01*	N/A	N/A	N/A
Malathion	N/A	N/A	N/A	0.43	100	160	N/A
Methyl Parathion	N/A	N/A	N/A	0.08*	2	2	N/A
Molinate/Odram	N/A	N/A	N/A	13*	N/A	20	N/A

* instantaneous maximum.

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. The EPA has established a fish tissue residue criterion of 0.3 mg methylmercury/kg fish (EPA 2001).

Sources: EPA 2003; Siepman and Finlayson 2000.

For Colusa Basin Drain, diazinon is a pollutant that is of particular concern. Of 118 samples collected by various programs from a data set received from the Central Valley Water Board, 30 samples, or approximately 25%, exceeded the DFG threshold of 0.05µg/L. Table 3-24 shows the samples from the Central Valley Water Board data set exceeding the diazinon threshold. The California Department of Pesticide Regulation (DPR) and the California Rice Commission monitor for several rice herbicides at the Colusa Basin Drain. However, this data was not used in this analysis. USGS data (downloaded from the USGS website) indicate that Colusa Basin Drain water quality is above the thresholds for several other pollutants. Of the 21 total samples from 1996 to 1998, concentrations of azinphos-methyl, and molinate/odram, each exceeded the threshold (0.01 and 13 µg/L) in one sample (4.8%), concentrations of diazinon exceeded the DFG Acute threshold (0.08 µg/L) in three samples (9.5%), and concentrations of carbofuran, malation, and methyl parathion did not exceed the threshold. See Table 3-24 for the results.

Table 3-24. Water Quality Statistics for Colusa Basin Drain

	Diazinon, from Regional Board (µg/L)	Diazinon, from USGS (µg/L)	Azimphos-methyl (µg/L)	Molinate/odram (µg/L)	Malation (µg/L)	Carbofuran/ furada (µg/L)	Methyl-Parathion (µg/L)
Earliest Date	Jan-94	Nov-96	Nov-96	Nov-96	Nov-96	Nov-96	Nov-96
Latest Date	May-06	Apr-98	Apr-98	Apr-98	Apr-98	Apr-98	Apr-98
Count	118	21	21	21	21	21	21
Minimum Concentration	0	0.002	0.001	0.009	0.005	0.03	0
Average Concentration	0.05	0.018	0.00285714 3	1.3742381	0.01128 6	0.07761905	0
Maximum Concentration	0.42	0.098	0.04	19.2	0.054	0.2	0
% Exceedances	25.4	9.5	4.8	4.8	0	0	0

The first diazinon data set is from the Central Valley Water Board 2005.
Source: USGS website.

Resource extraction, including but not limited to mercury mining, is the primary source identified for mercury impairment in Lower Cache Creek. Sulphur Creek, Bear Creek, and Harley Gulch are the major contributors of mercury to lower Cache Creek. Data downloaded from the BDAT website indicate that lower Cache Creek exceeds the CTR mercury threshold of 0.05 µg/L in 10 of 16 samples, which is equal to 62.5% of the samples downstream of the settling basin. In addition to analyzing data downstream of the settling basin, Cache Creek at Road 102 (upstream of the settling basin) was analyzed and exceeded the CTR mercury criteria in 19 of 28 samples, or 67.8% of the time. (Tables 3-24 and 3-25) (BDAT 2005). Data for Sulphur Creek, Bear Creek, and Harley Gulch were not available on the USGS or BDAT websites. For a more detailed analysis of the water quality of the Sacramento River near the southeastern corner of the Colusa Basin Subwatershed, refer to the Butte-Sutter-Yuba Subwatershed.

Table 3-25. Cache Creek Mercury Concentrations

	Mercury (µg/L)	
	Cache Creek downstream of Settling Basin	Cache Creek at Road 102
Earliest Date	Dec-96	Jan-95
Latest Date	Feb-98	Feb-98
Count	16	28
Minimum Concentration	0.004	0.012
Average Concentration	0.5	0.23
Maximum Concentration	2.21	0.98
% Exceedances	62.5	67.8

Source: USGS website.

Sacramento River Basin—Butte-Sutter-Yuba Subwatershed

General Description

The Butte–Sutter-Yuba Subwatershed is located in northern California and is framed by Oroville Dam to the north, the Sutter Bypass to the west and south, and the Sacramento River to the west and south. The five main water features in the Butte-Sutter-Yuba Subwatershed are the Feather River, Lake Oroville, the Yuba River, the Bear River, and the Sacramento River. The Butte-Sutter-Yuba Subwatershed is approximately 1,697,969 acres. Elevation ranges from 91 feet in the west to 6,754 in the east (SVWQC 2004). The Feather River and the Sacramento River drainages generally flow from north to south, and the Yuba and Bear River generally flow east to west until their confluence with the Feather River. (Figure 3-8.)

Annual precipitation varies with elevation and ranges from 15 inches in western Sutter County to 80 inches in the northeast corner of Yuba County. The total annual precipitation is 21.04 inches at Marysville, on the boundary between the two counties, at an elevation of 65 feet. Of this, more than 7 inches, or nearly 34%, usually falls in March through October. Thunderstorms occur on about 5 days each year, and most occur in April. In the valley, snowfall is rare. At Marysville, the greatest snow depth at any one time during the period of record and the heaviest 1-day snowfall on record were 1 inch on December 13, 1972 (SVWQC 2004).

Feather River

The middle fork and south fork of the Feather River are located in Plumas County, outside of the Butte-Sutter-Yuba Subwatershed, but a large portion of the North Fork Feather River is located within the subwatershed. The North Fork Feather River feeds the north arm of Lake Oroville. The Feather River drains an area of approximately 2,304,000 acres at Lake Oroville (MBK Engineers and Flood Control Study Team 2002). The USGS monitors flow on the Feather River near Oroville, California (11407000), and monthly average flows are included in Table 3-26 below.

Lake Oroville

Lake Oroville lies in the foothills on the western slope of the Sierra Nevada Mountains, 1 mile downstream of the confluence of the river’s forks. With a capacity of more than 3.5 million acre-feet, the lake is the largest State Water Project (SWP) facility, storing runoff to the Feather River and providing flood control and water for recreation; freshwater releases from Lake Oroville help control salinity intrusion in the Delta and support fish and wildlife and their habitats (DWR 2005).

Yuba River

The Upper Yuba River, including New Bullards Bar Reservoir, is located in Plumas County and is outside the Butte-Sutter-Yuba Subwatershed. The 60 river miles of the Yuba River between the New Bullards Bar release and the confluence with the Feather River near Marysville California, are within the subwatershed. In this reach, the Yuba River feeds Englebright Lake, a 9-mile-long, slender lake with a capacity of approximately 70,000 acre-feet (CDEC 2005). Most of the water exported from the Yuba Basin is diverted from the headwaters of the middle and south forks of the Yuba River into the Bear River watershed through facilities of Nevada Irrigation District and the Pacific Gas and Electric Company (PG&E). The USGS monitors flow on the Yuba River near Marysville, California (11421000), and monthly average flows for the Yuba River are included in Table 3-26.

Bear River

The Bear River originates in the vicinity of Emigrant Gap and Lake Spaulding in the Sierra Nevada foothills and flows southwest to intersect the Feather River upstream of the city of Nicolaus. The entire Bear River drainage area is 352,000 acres (MBK Engineers and Flood Control Study Team 2002). All upstream reservoirs on the Bear River are outside the Butte-Sutter-Yuba Subwatershed and are not discussed in this analysis. The section of Bear River that falls in this Subwatershed starts just downstream of Camp Far West Reservoir and drains into Feather River. Bear River flows below Camp Far West Reservoir are shown in Table 3-26.

Butte Slough/Sacramento Slough/Sutter Bypass

The drainage basin of Butte Slough lies east of the Sacramento River, south of Big Chico Creek, and north of the Sutter Buttes. Butte Slough begins near the confluence of Butte Creek and the Sacramento River and flows for approximately 7.5 miles until it empties into the Sutter Bypass (Central Valley Water Board 2001). Butte Slough drains into the Sacramento River upstream of the Feather River confluence near Colusa, California. The majority of Butte Slough water comes from the Butte Creek Watershed, where Butte Creek enters Butte Slough near the Butte Slough Outfall gates just before the Butte Slough confluence with the Sacramento River. During periods of normal flow, the Sutter Bypass enters the Sacramento River via the Sacramento Slough. During periods of high flow, the Sutter Bypass channel fills completely and is diverted to the Sacramento River.

Sacramento River

The Sacramento River is the largest river in California both in volume of flow, and in drainage area. The Feather River drains into the Sacramento River at Verona, California, just upstream of the Sacramento International Airport. The Sacramento River at Verona is the combination of flow for the entire Butte-Sutter-Yuba Subwatershed and all upstream Sacramento River flows from east- and west-side tributaries, including flow releases from Lake Shasta. The Sacramento River flow at Verona is regulated by coldwater releases from Shasta Dam and Oroville Dam.

Table 3-26. Monthly Average Flows for All Available Locations in the Butte-Sutter-Yuba Subwatershed

	Feather River near Oroville			Yuba River near Marysville			Bear River below Camp Far West Reservoir			Sacramento River near Verona			Sutter Bypass			Butte Creek Near Chico		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	618	3,338	26,748	828	5,522	26,180	12	14	22	15,416	37,717	71,035	34	4,117	35,080	175	1,033	2,847
Feb	619	2,256	7,241	1,024	5,470	11,056	11	14	19	16,034	44,100	69,817	0	4,389	35,110	424	1,068	2,266
Mar	617	2,684	18,873	864	5,000	14,119	11	14	22	17,752	38,249	62,248	0	4,409	35,140	318	935	2,601
Apr	615	907	3,429	780	3,193	6,542	24	27	32	10,397	24,617	52,577	20	323	855	285	715	1,510
May	620	1,390	7,007	302	3,667	9,230	26	28	30	7,802	22,375	49,810	877	1,359	1,641	208	620	1,314
Jun	617	635	668	263	2,526	7,289	26	27	30	10,532	18,907	44,507	1,190	1,444	1,626	178	355	773
Jul	621	659	719	845	1,554	2,747	10	11	13	13,384	18,024	21,681	1,456	1,548	1,649	125	192	356
Aug	618	665	798	939	1,548	2,242	10	11	13	12,132	16,525	21,255	746	1,303	1,456	115	151	211
Sep	623	637	658	463	796	1,398	10	11	13	11,175	14,593	20,997	558	775	893	100	132	183
Oct	627	814	1,594	431	785	1,145	11	13	14	7,360	9,809	12,881	395	672	1,365	83	128	186
Nov	626	883	1,624	443	823	1,620	12	13	18	10,201	11,923	18,437	506	611	880	114	201	367
Dec	619	1,555	7,728	696	2,206	8,036	12	14	16	11,658	25,271	44,855	367	513	690	135	557	1,809

Flows are in cfs and monthly average flows from 1995–2004 (or unless otherwise stated).

Source: Data obtained from USGS website.

Land Use Patterns

Although significant differences in irrigated acres and crop types are apparent among available information sources, the relative proportions of each crop type are similar. The DWR land use data were used for the purposes of this report, as they were the only data where crop types could be identified and delineated by drainage areas. The DWR methodology uses aerial photos and relies upon field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize drylandcrops as irrigated crops and may create a small amount of crossover.

Table 3-27 shows the land use acreage according to DWR and FRAP land use data for the Butte-Sutter-Yuba Subwatershed. Native vegetation covers just over half (57%) of the subwatershed, mainly in the upper and eastern parts away from the developed section. Of this, the majority is irrigated. Rice is the most abundant crop of the irrigated land with 15.35% of the usage. According to the DWR land use map (Figure 3-16, yellow shading), south of the City of Chico, rice production dominates the landscape along the border with Yolo County. Production of deciduous fruits and nuts is second at 9.55% and makes up a generous portion of the southern half of the Feather River acreage as well as area near the city of Chico and the Bear River. Field crops, which account for 3.48% of the total acreage, follows southern tributaries along the Yuba River and around Lake Oroville and the north fork of the Feather River.

Urban use and landscape, primarily in the western part of the subwatershed occupies 3.86% of the landscape, spread out over the western portion of the map (see gray shading in Figure 3-16). Idle lands are 2.06% of the total and are likely nonproducing.

Table 3-27. Land Use Acreage according to DWR and FRAP Land Use Data for the Butte-Sutter-Yuba Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	8,173.94	0.482
Deciduous Fruits and Nuts	161,944.39	9.551
Field Crops	59,122.08	3.487
Grain and Hay	26,300.53	1.551
Idle	16,987.96	1.002
Pasture	33,003.34	1.946
Rice	260,439.41	15.360
Semiagricultural and Incidental	5,870.82	0.346
Truck, Nursery, and Berry Crops	35,371.15	2.086
Vineyards	589.67	0.035
Subtotal	607,803.29	35.846
Urban		
Urban—unclassified	34,311.54	2.024
Urban Residential	20,589.35	1.214
Urban Landscape	2,001.52	0.118
Commercial	2,045.16	0.121
Industrial	6,507.55	0.384
Vacant	6,782.71	0.400
Subtotal	72,237.83	4.261
Native		
Native Vegetation	889,633.41	52.467
Barren and Wasteland	11,279.16	0.665
Riparian Vegetation	62,446.83	3.683
Water Surface	37,538.35	2.214
Subtotal	1,000,897.75	59.029
FRAP Land Use Type		
Agriculture	30.71	0.002
Annual Grassland	1,957.70	0.115
Barren	13.76	0.001
Blue Oak Woodland	3,152.02	0.186
Blue Oak-Foothill Pine	700.04	0.041
Douglas-Fir	20.82	0.001
Mixed Chaparral	217.74	0.013
Montane Hardwood	5,851.02	0.345
Montane Hardwood-Conifer	1,279.48	0.075
Ponderosa Pine	1,187.89	0.070
Urban	94.13	0.006
Valley Oak Woodland	65.58	0.004
Water	86.52	0.005
Subtotal	14,657.41	0.864
Total	**1,695,596**	**100**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Butte-Sutter-Yuba Subwatershed. Table 3-28 lists the beneficial uses of Feather River, Butte Creek (to Butte Slough), Sutter Bypass, Yuba River (to Englebright Reservoir and Englebright Dam to Feather River), and Upper Bear River.

Table 3-28. Beneficial Uses by River Sub-Areas

Beneficial Uses	Feather River (from Oroville to the Sacramento River)	Sutter Bypass	Yuba River to Englebright Reservoir	Yuba River – Englebright Dam to Feather River	Upper Bear River	Butte Creek to Butte Slough
Municipal & Domestic	E		E		E	
Irrigation	E	E	E	E	E	E
Stock Watering			E	E	E	E
Process						
Service Supply				E		
POW (Power)			E	E	E	E
Rec-1	E	E	E, E	E, E	E, E	E
Rec-2	E		E	E	E	
Freshwater Habitat—Warm	E			E	E	E
Freshwater Habitat—Cold	E		E	E	E	E
Migration—Warm	E			E	P	
Migration—Cold	E	E		E	P	E
Spawning—Warm	E	E		E	P	E
Spawning—Cold	E		E	E	P	E
Wildlife Habitat	E	E	E	E	E	E
Navigation						

P = Potential, E = Existing, U = Undefined.

Data obtained from the Sacramento San Joaquin River Basin Plan. Rec-1 is contact and canoeing or rafting, and Rec-2 noncontact.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant is prioritized in the 303(d) list. Multiple water bodies are listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. Identified sources of impairments in the Butte-Sutter-Yuba Subwatershed are limited to agricultural and resource extraction (mining).

According to the CWA Section 303(d) list of water quality impaired rivers, the Sutter Bypass, Butte Slough, and the Lower Bear River (below Camp Far West Reservoir) are listed as impaired for diazinon, and all have a medium TMDL priority. The Feather River is listed as impaired for diazinon Group A pesticides, mercury, and unknown toxicity. Englebright Lake, part of the Lower Bear River, is listed as impaired for mercury, and the Sacramento Slough is listed as impaired for diazinon and mercury. Lastly, the Sacramento River (from Knights Landing to the Delta) is listed as impaired for diazinon, mercury, and unknown toxicity. The Central Valley Water Board has developed and adopted a TMDL for the Sacramento and Feather Rivers that is now in effect. More information about the TMDL can be obtained from:

> <http://www.waterboards.ca.gov/centralvalley/programs/tmdl/sac_feather_diaz/index.html>.

Table 3-29 contains the TMDL priority status for the water bodies listed. Potential sources for the following impairments are considered to be attributable to agriculture and resource extraction.

Table 3-29. CWA 303(d) Impaired Status for the Butte-Sutter-Yuba Subwatershed

Watershed/Subwatershed	Pollutant	Potential Sources	TMDL Priority	Estimated Size Affected
Sutter Bypass	Diazinon	Agriculture	Medium	19 miles
Lower Bear River (below Camp Far West Reservoir)	Diazinon	Agriculture	Medium	21 miles
Butte Slough	Diazinon	Crop-related sources	Medium	8.9 miles
Feather River	Diazinon	Agriculture and urban runoff/storm sewers	High	42 miles
	Group A pesticides	Agriculture	Medium	42 miles
	Mercury	Resource extraction (abandoned mines)	Medium	42 miles
	Unknown toxicity	Source unknown	Low	42 miles
Englebright Lake	Mercury	Resource extraction (abandoned mines)	Medium	754 acres
Sacramento Slough	Diazinon	Agriculture and urban runoff/storm sewers	Medium	1.7 miles
	Mercury	Source unknown	Low	1.7 miles
Sacramento River (Knights Landing to the Delta)	Diazinon	Agriculture	High	16 miles
	Mercury	Resource extraction (abandoned mines)	Medium	16 miles
	Unknown toxicity	Source unknown	Low	16 miles

Source: Data obtained from CWA Section 303(d)

Water Quality

According to water quality data for the Upper Feather River, the quality of water entering the north fork of Lake Oroville is excellent, and Lake Oroville also generally has excellent water quality. The Upper North Fork of the Feather River and Lake Oroville are not listed as impaired on the CWA Section 303(d) list for any contaminants, but the Feather River from Oroville Dam to its confluence with the Sacramento River is impaired for diazinon, Group A pesticides, mercury, and unknown toxicity (Table 3-30). Of the Group A pesticides, dieldrin is the only water column sample analyzed because the remaining Group A pesticides are sampled as riverbed samples and this analysis is concerned only with water column samples.

Table 3-30. Diazinon and Dieldrin Criteria

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)	
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL or DWEL	CDHS
Diazinon	0.05	0.08	0.1	0.1	0.6001	6
Dieldrin (Group A Pesticides)	NA	NA	0.056	0.24	2.02	0.002

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations.
Sources: EPA 2003; Siepman and Finlayson 2000.

The Feather River was sampled near Nicolas, California, from 2000 to 2001 for diazinon and Group A pesticide dieldrin. Of 24 total water quality samples, five (21%) diazinon samples exceeded the DFG criteria of 0.05. However, no diazinon samples exceeded the EPA-SNARL criteria. Of 24 total water quality samples, 0 dieldrin samples exceeded the EPA chronic criteria. See Table 3-31 below for results.

The Butte Slough at Mawson Bridge near Colusa, California, was sampled and data were downloaded from the USGS website. Seven samples were taken in 2002, and 5 of 7 diazinon samples (71%) exceeded the DFG criteria. Data are at Mawson Bridge in Table 3-31.

Table 3-31. Diazinon in Butte Slough at Mawson Bridge near Colusa, California

	Feather River near Nicolas	Feather River near Nicolas	Butte Slough at Mawson Bridge	Sacramento Slough near Knights Landing
	Diazinon (µg/L)	Dieldrin (µg/L)	Diazinon (µg/L)	Diazinon (µg/L)
Earliest Date	Jan-00	Jan-00	Jan-02	Nov-96
Latest Date	Feb-01	Feb-01	Feb-02	Sep-06
Count	24	24	7	35
Minimum Concentration	0.008	0.001	0.017	0.002
Average Concentration	0.032	0.003	0.056	0.0135
Maximum Concentration	0.154	0.005	0.077	0.106
% Exceedances	20.8	0	71.4	2.8

Source: USGS website.

The Sacramento Slough near Knights Landing was sampled, and data were downloaded from the USGS website. One of 35 diazinon (2.8%) samples in the Sacramento Slough exceeded the DFG criteria of 0.05 µg/L (see Table 3-31, above). The USGS website contained no mercury data for Sacramento Slough near Knights Landing.

The Sutter Bypass is listed as impaired for diazinon; however, the USGS website does not show any water quality samples with diazinon concentrations. As a result, diazinon samples are needed to adequately address the water quality of the Sutter Bypass.

The USGS website also did not have any diazinon or mercury data for the Bear River below Camp Far West Reservoir and the Sacramento River near Verona. Both the Lower Bear River and the Sacramento River are listed as impaired for diazinon and/or mercury.

Sacramento River Basin—Lake-Napa Subwatershed

General Description

The Lake-Napa Subwatershed is located in the central Coastal Range of northern California. The subwatershed borders to the west are Mendocino, Sonoma and Napa Counties. To the east are the Colusa, Yolo, and Solano Counties. To the north is Mendocino County, and to the south are Napa and Solano Counties. Portions of the Eel River watershed, which drain to the ocean near Eureka, are within the subwatershed's northerly reaches. The two primary drainages in the Lake-Napa Subwatershed are Upper Cache Creek and Upper Putah Creek, which comprise all Lake County terrain that drains to the Sacramento Valley (SVWQC 2004). Besides these, the major features of the subwatershed are Clear Lake and Lake Berryessa, which occupy the majority of surface water area. The entire Lake-Napa Subwatershed is approximately 897,881 acres (Figure 3-9).

The Lake-Napa Subwatershed has a Mediterranean climate, which is characterized by warm, dry summers and moist, cool winters. The average winter temperature in Lakeport is 44ºF, and the average daily minimum is 33ºF. The average summer high temperature for Lakeport is 71ºF, and the average daily maximum is 91ºF. Precipitation in the Clear Lake area generally occurs only as rainfall. At lake level, the average annual rainfall is 30 inches per year, and the amount increases considerably at higher elevations (SVWQC 2004).

Upper Cache Creek

The Upper Cache Creek watershed is divided into two parts, the North Fork and the Main Fork. All secondary tributaries in this watershed are flashy seasonal streams. Normal desiccation occurs in June, and flows return as early as September or as late as December (SVWQC 2004).

The North Fork Cache Creek, the smaller of the two tributaries in this watershed, consists of almost 183,000 acres (Table 3-32) and has no major tributaries. Its agricultural operations are minor. This watershed originates in the upper reaches of the northeastern boundaries in Lake County and collects to form Indian Valley Reservoir. Small patches of agriculture are located several miles below the reservoir in what is known as Long Valley. This valley hosts one commercial nursery, small acreages of irrigated pasture and dry-farmed walnuts, and small acreages of wine grapes that have been planted on benches and ridges (SVWQC 2004).

Table 3-32. Acreages of Major Subwatersheds

Watershed/Subwatershed	Basin Acreage
North Fork Cache Creek	183,000
Upper Cache Creek	295,000
Upper Putah Creek	132,000

Source: SVWQC Watershed Evaluation Reports 2004.

The larger of the two tributaries to the Upper Cache Creek watershed is the Main Fork, comprising almost 295,000 acres of watershed. Its tributaries are those of Clear Lake, which is the largest natural freshwater lake located entirely within California (SVWQC 2004). Monthly average flows from 1995 to 2004 for Cache Creek near Lower Lake can be found in Table 3-33 below.

A small portion of the Lower Cache Creek is located within the Lake-Napa Subwatershed. Some minor tributaries that join this lower portion of Cache Creek within the Lake-Napa Subwatershed are Bear Creek and Harley Gulch.

Clear Lake

Clear Lake is believed to be the oldest lake in North America. Limnologists estimate its age to be 500,000 to 2.5 million years old. The lake acts as a collection basin for waters emanating from the western and central portions of the county. Surface area of the water body is 60 square miles, and its shoreline is slightly more than 100 miles. Clear Lake is 18 miles long (7.5 miles across at its widest point) with a watershed of approximately 500 square miles (SVWQC 2004).

Clear Lake is characterized as eutrophic with no thermocline. Depths range from 20 to 50 feet and storage capacity is estimated to be approximately 313,000 acre-feet. However, Clear Lake Monitors Lake Level between 0 and 7.56 feet near Rumsey, the unique scale by which Clear Lake levels have been monitored for more than 100 years (SVWQC 2004). Clear Lake is composed of three arms. The upper arm (28,000 acres, mean depth 23 feet) is by far the largest and the shallowest arm. Big Valley Creek, Middle Creek, and Scotts Creek flow into this upper arm of Clear Lake. To the southeast is the lower arm (8,200 acres, mean depth 34 feet). The deepest points of Clear Lake are found here, as is its drain, Cache Creek, located at the southeastern end. The smallest arm is the oaks arm (2,800 acres, mean depth 36 feet), which extends to the northeast. This arm is noted for its proximity to Sulphur Bank Mine, an abandoned mercury source listed as an EPA Superfund site (SVWQC 2004). Approximately 30% of lake inflow is from the Scotts Creek and Middle Creek, which enter the lake through

Rodman Slough. Clear Lake discharges into Cache Creek through the Clear Lake Dam, which is approximately 5 miles downstream of the lake.

Upper Putah Creek/Lake Berryessa

The second main hydrological unit is Upper Putah Creek, which is almost 132,000 acres in size. Upper Putah Creek is approximately 35 miles long and drains into Lake Berryessa. This watershed has many small seasonal creeks that flow into Putah Creek via Soda, Coyote, Big Canyon, Harbin, and Dry Creeks (SVWQC 2004). However, most of these creeks are seasonal flashy flows. Monthly average flows from 1998 to 2004 for Upper Putah Creek near Guenoc, California, can be found in Table 3-33 below. With a storage capacity of 1,602,000 acre-feet, Lake Berryessa is the major water feature of the Napa County portion of the Lake–Napa Subwatershed. On the east, its lower reach touches the borders of Solano and Yolo Counties. To the northwest, Upper Putah Creek is a tributary to the lake.

Table 3-33. Cache Creek and Putah Creek Flows from USGS Gaging Stations

Month	Cache Creek near Yolo			Cache Creek near Lower Lake			Putah Creek near Guenoc		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	81	2,322	7,177	4	987	3,047	133	432	676
Feb	181	3,081	12,617	4	1,459	4,988	132	764	1,295
Mar	108	2,391	7,003	7	1,325	3,957	137	332	557
Apr	23	796	2,843	11	616	2,187	47	166	352
May	15	267	812	180	541	761	20	97	264
Jun	5	73	418	180	483	702	4	36	145
Jul	3	38	141	153	482	641	1	9	37
Aug	3	38	139	250	390	505	0	3	11
Sep	2	37	106	5	228	326	0	1	7
Oct	1	40	73	5	86	182	0	2	8
Nov	5	41	82	2	4	6	10	79	201
Dec	17	537	1,622	3	71	255	21	564	1,444

Flows are in cfs and monthly flows from 1995–2004.
Source: USGS website.

Land Use Patterns

DWR uses an aerial mapping system to track land use across the state. Of Lake County's 850,846 acres, agricultural land use makes up 28,450 acres or 3.3%, according to 2001 aerial maps (Figure 3-17). Approximately 12% of the total land acreage is for private uses, and much of that has been developed in the areas surrounding the two largest bodies of water.

Lyons Creek Wetlands, small, actively managed wetlands that are part of the Northwest Sewage Treatment Plant, are located northwest of Clear Lake. This wetland area is estimated to total less than 3 acres in extent.

With 85.9% of the total acreage, undeveloped native vegetation occupies the majority of land in the subwatershed, followed by surface water. Urban areas and urban landscape combine for a small percentage, just over .08% of the total area. Based on the DWR map, most urbanized and commercial areas are near Clear Lake and Lake Berryessa, likely small communities that subsist off of the recreation industry in those areas. Industrial uses are very minor and spotty across the landscape, with the exception of those near major highways.

Riparian vegetation occurrence is greatest along the edge and south eastern side of Clear Lake, because of the number of small creeks and streams that run out of that area of the lake. DWR states that just over 1.2% of the total area is used solely for pasture and idle lands (see Table 3-34 below).

The majority of irrigated land use occurs around Clear Lake. In the southwestern portion of the Clear Lake area, within 2–3 miles of the lake, deciduous fruit and nut production dominates. Vineyards are the second most abundant of total land use in Lake County and the most abundant in terms of irrigated land. In Napa County, vineyards also play a substantial role in the watershed, combining for a total of more than 12,000 acres total for both counties. Interspersed with the orchards and vineyards are open pasture and idle lands, which combine for more 10,000 acres.

Table 3-34. Lake-Napa Subwatershed DWR Land Use Types

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	5	0.001
Deciduous Fruits and Nuts	11,122	1.24
Field Crops	8	0.001
Grain and Hay	2,079	0.23
Idle	5,077	0.57
Pasture	5,905	0.66
Rice	941	0.10
Semiagricultural and Incidental	961	0.11
Truck, Nursery, and Berry Crops	199	0.02
Vineyards	12,320	1.37
Subtotal	38,617	4.30
Urban		
Urban—unclassified	367	0.04
Urban Residential	16,874	1.88
Urban Landscape	352	0.04
Commercial	1,466	0.16
Industrial	1,743	0.19
Vacant	667	0.07
Subtotal	21,469	2.38
Native		
Native Vegetation	770,172	85.87
Barren and Wasteland	1,012	0.11
Riparian Vegetation	1,400	0.16
Water Surface	65,212	7.27
Subtotal	837,796	93.41
Total	**896,865**	**100.00**

Pesticide use within the Lake-Napa Subwatershed consists of pesticides applied to lands in the Napa County Putah drainage, and the majority are applied to wine grapes. However, it is important to note that no water bodies in the Lake-Napa Subwatershed are listed as impaired for any pesticides. For more information on impaired water bodies, refer to the Impaired Status section. Table 3-35 summarizes pesticide use data compiled by the Napa County Agricultural Commissioner's office. A total of 34 growers, (30 wine grape, 1 pasture, and 3 oat hay) reported usage in the subwatershed (SVWQC 2004).

Table 3-35. Pesticide Use in Napa County Putah Drainage

Pesticide/Active Ingredient	Type of Pesticide	Amount of Pesticide Product*
Acetamiprid	Insecticide	11.9 lbs.
Avermectrin	Insecticide	0.8 gal.
Axoxystrobin	Fungicide	65.4 gal.
Bacillis subatilis	Insecticide	944.5 lbs.
Benomyl	Fungicide	5.0 lbs.
Bifenazate	Insecticide	21.1 lbs.
Capsaicin	Animal repellant	5.5 gal.
Carbaryl	Insecticide	5.0 lbs.
Copper hydroxide	Fungicide	291.4 gals.
Copper oxide	Fungicide	10.0 lbs.
Cyprodinil	Fungicide	29.4 lbs.
Dicloran	Fungicide	371.5 lbs.
Diquat dibromide	Herbicide	0.1 gal.
Fenarimol	Fungicide	7.8 gal.
Glyphosate	Transl. Herbicide	878.5 gal.
Hydrazine carboxyl acid	Acaracide	104.2 lbs.
Imidacloprid	Insecticide	27.8 lbs.
Kresoxim-methyl	Fungicide	52.0 lbs.
Mancozeb	Fungicide	30.3 gal.
Myclobutanil	Fungicide	431.1 lbs.
Napropamide	Herbicide	48.0 lbs.
Oryzalin	Herbicide	119.3 gal.
Oxyfluorfen	Herbicide	193.7 gal.
Paraquat	Contact Herbicide	0.7 gal.
Pendimethalin	Herbicide	22.0 gal.
Penetrants	Adjuvant	4.0 gal.
Petroleum distillate	Insecticide	3.4 gal.
Potassium bicarbonate	Fungicide	1818.4 lbs.
Pyridaben	Insecticide	30.8 lbs.
Simazine	Pre-Em. Herbicide	289.4 lbs.
Spreader binder adjuvant	Adjuvant	154.4 gal.
Sulphur	Fungicide/Insecticide	75882.5 lbs.
Tebuconazole	Fungicide	173.8 lbs.
Trifloxystrobin	Fungicide	98.5 lbs.
Trifumuzole	Fungicide	81.9 lbs.

lbs = pounds, gal = gallons.

* Data reflects amount of manufactured product used, not active ingredient. Most manufactured products include inert ingredients, some at a very high percentage of the total product.

Source: SVWQC 2004.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Lake-Napa Subwatershed. Table 3-36 lists the beneficial uses of Cache Creek (Clear Lake and Clear Lake to Yolo Bypass) and Putah Creek (Lake Berryessa and Lake Berryessa to Yolo Bypass).

Table 3-36. Beneficial Uses by River Sub-Areas

	Cache Creek		Putah Creek	
Beneficial Uses	Clear Lake	Clear Lake to Yolo Bypass	Lake Berryessa	Lake Berryessa to Yolo Bypass
Municipal & Domestic	E	E	E	E
Irrigation	E	E	E	E
Stock Watering	E	E	E	E
Process		E		
Service Supply		E		
POW (Power)			P	
Rec-1	E	E	E	E
Rec-2	E	E	E	E
Freshwater Habitat—Warm	E	E	E	E
Freshwater Habitat—Cold	P	P	E	P
Migration—Warm				
Migration—Cold				
Spawning—Warm	E	E	E	E
Spawning—Cold		E		
Wildlife Habitat	E	E	E	E
Navigation				

P = Potential, E = Existing, U = Undefined.

Rec-1 is contact and canoeing or rafting, and Rec-2 non-contact. Clear Lake is also designated for COMM, which stands for commercial and sport fishing.

Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. The Lake-Napa Subwatershed includes two main rivers on the list that was last updated by the EPA in July 2003. Identified sources of impairment in the Lake-Napa Subwatershed are agricultural and resource extraction (mining).

According to the CWA Section 303(d) list of water quality–impaired rivers, Cache Creek (from Clear Lake to Yolo Bypass) is impaired for mercury and unknown toxicity. However, it is important to note that only a small portion of Cache Creek to Yolo Bypass is within the Lake-Napa Subwatershed. Clear Lake is listed as impaired for mercury and nutrients. Lake Berryessa is listed as impaired for mercury. Clover Creek, which ultimately drains into the north fork of Upper Cache Creek, is listed as impaired for fecal coliform. Harley Gulch and Bear Creek, part of the Lower Cache Creek watershed, are listed as impaired for mercury. The Central Valley Water Board has adopted a Basin Plan amendment incorporating the mercury TMDL for Cache Creek. The State Board, Office of Administrative Law, and the EPA must still approve the Basin Plan Amendment before it becomes effective. In addition, the Central Valley Water Board has adopted a TMDL addressing mercury in Clear Lake that has been accepted by the State Board, Office of Administrative Law. Currently, Central Valley Water Board staff are working on a nutrient TMDL that is scheduled to be presented in the Summer of 2006. Table 3-37 shows the TMDL priority status for the watersheds. Potential sources of the impairments are considered to be agriculture, agriculture—grazing, silviculture, and resource extraction.

Table 3-37. Impaired Status by River Sub-Areas

Watershed/Subwatershed	Pollutant	Potential Sources	TMDL Priority	Estimated Size Affected
Lake Berryessa	Mercury	Resource extraction	Low	19,083 acres
Cache Creek (from Clear Lake to Yolo Bypass)	Mercury	Resource extraction (abandoned mines)	Medium	96 miles
	Unknown toxicity	Source unknown	Low	96 miles
Harley Gulch	Mercury	Resource extraction (abandoned mines)	Medium	6 miles
Bear Creek	Mercury	Resource extraction	Medium	15 miles
Clear Lake	Mercury	Resource extraction	High	40,070 acres
	Nutrients	Source unknown	Medium	40,070 acres
Clover Creek	Fecal coliform	Agriculture—grazing and Other	Low	11 miles
James Creek	Mercury	Resource extraction (abandoned mines)	Low	6.3 miles
	Nickel	Resource extraction (abandoned mines)	Low	6.3 miles

Source: CWA Section 303(d).

Water Quality

Since 1992, the Department of Public Works for Lake County Water Resources Division has conducted water quality monitoring tests for sediment, DO, nitrogen, and phosphorus in three tributaries of Clear Lake. In addition, lake monitoring by the county’s Vector Control Department includes biological sampling as well as water clarity readings. Over the past century, Secchi depth readings in Clear Lake have been conducted by various agencies. Results of the Secchi depth show a consistent increase in clarity since the 1950s. Historical literature also supports a transition from a nutrient-rich algae–dominated lake to a notably clear, macrophyte-dominated lake environment (SVWQC 2004).

According to the Napa Agriculture Commissioner's data, elemental sulfur is the pesticide with the by far greatest usage in the Putah Creek watershed, followed distantly by glyphosate herbicide (SVWQC 2004). SVWQC reports conclude that FQPA I & II pesticide use in Napa County declined significantly between 1993 and 2001 and substantiate that a high number of growers use only sulfur and glyphosate in their vineyards based on a personal communication with Minghua Zhang (mhzhang@ucdavis.edu) from UC Davis.

Clear Lake has two 303d listings—a 2002 TMDL order for mercury with a December 31, 2005, anticipated submittal deadline and a "medium" rating for nutrients with an unknown date for TMDL submittal deadline. The mercury TMDL for Clear Lake identifies resource extraction to be the primary source with unknown sources from the tributaries and requires that the unknown sources be identified and loads reduced. Nutrient reduction responsibilities have been identified in the draft TMDL report. Lake Berryessa is also listed as impaired for mercury, along with Putah Creek and Cache Creek. Clover Creek is listed as impaired for fecal coliform. Harley Gulch and Bear Creek are listed as impaired for mercury.

The Central Valley Water Board has the *Public Review of The Water Quality Control Plan for the Sacramento and San Joaquin River Basins for the Control of Mercury in Cache Creek, Bear Creek, Sulphur Creek, and Harley Gulch*. This report states that the highest concentrations of mercury were below the mercury mines in Harley Gulch, Sulphur Creek, and Bear Creek; however, Sulphur Creek and Bear Creek are just outside of the Lake-Napa Subwatershed, and Harley Gulch is just inside. The Upper Cache Creek Watershed is not seen as a large mercury problem because these locations are downstream of Clear Lake.

Sacramento River Basin—Solano-Yolo Subwatershed

General Description

The Solano-Yolo Subwatershed, located in northwestern California, reaches Nevada and Sutter Counties to the north and San Joaquin County to the south. To the east is Sacramento County, and to the west are Napa, Sonoma, and Marin Counties. The Solano-Yolo Subwatershed is approximately 899,539 acres. Figure 3-10 delineates the Solano-Yolo Subwatershed. The major water features in the subwatershed are Putah Creek, the Lower Sacramento River, and the Sacramento Deep Water Ship Channel. Putah Creek flows from Lake Berryessa (which is outside this subwatershed) and joins the Sacramento River just south of the City of West Sacramento. The Sacramento River generally makes up the eastern boarder in the northern section of the Solano-Yolo Subwatershed, and gradually migrates southwest into the boundary of the subwatershed until it meets the San Joaquin River, combining to form the Delta near the city of Antioch.

The western part of the subwatershed consists of hilly to very steep mountainous uplands of the Coast Ranges that have a maximum elevation of 2,819 feet above sea level. The rest of the subwatershed is on the floor of the Central Valley. The Solano-Yolo Subwatershed has hot, dry summers and cool winters; the area near the Pacific Ocean, to the south and west, has cool, humid summers and moderate winters. In the summer there is a steady marine wind that blows up the Carquinez Strait. Average annual precipitation ranges from 16 inches in some of the southern parts of the subwatershed to as much as 30 inches at the top of the Vaca Mountains. Approximately 95% of the precipitation falls during the months of October through April (SVWQC 2004).

Putah Creek

Upper Putah Creek feeds Lake Berryessa; Lower Putah Creek drains out of the bottom of Lake Berryessa until its confluence with the Yolo Bypass. Upper Putah Creek and Lake Berryessa are in the Lake-Napa Subwatershed, however, and discussed in detail in that section. This subwatershed includes the Lower Putah Creek watershed. Lower Putah Creek defines the boundary between Yolo and Solano Counties except for approximately the last 15 river miles. The CDEC website shows flows for Putah Creek near Winters. Monthly minimum, mean, and maximum flows from 1995 to 2004 are given in Table 3-38 below.

Sacramento River/Sacramento Deep Water Ship Channel

Joining the Solano-Yolo Subwatershed in the northeastern corner, the lower Sacramento River is the primary water feature in the subwatershed. The northeastern boundary is where the Feather River meets the Sacramento River near Verona. The Sacramento River around the Sacramento metropolitan area is the legal boundary to delineate the Delta because downstream of Sacramento, the Sacramento River experiences tidal fluctuations. However, many regulatory agencies define the Delta boundary as where the Sacramento River meets the San Joaquin River. Monthly average minimum, mean, and maximum flows from 1995 to 2004 for the Sacramento River at Freeport are included in Table 3-38 below.

The Sacramento Deep Water Ship Channel was built to provide easy access for ships to the Sacramento metropolitan area. The channel splits from the Sacramento River just north of the city of Rio Vista and travels north along the west side of the Sacramento River until it ends in the City of West Sacramento.

There are no known flow stations on the Sacramento River Deep Water Ship Channel.

Table 3-38. Flows in the Solano-Yolo Subwatershed

	Sacramento River at Freeport			Putah Creek near Winters		
	Min	Mean	Max	Min	Mean	Max
Jan	17,251	43,997	87,116	66	116	438
Feb	18,232	52,203	80,867	67	274	607
Mar	21,316	44,644	74,782	81	292	629
Apr	12,178	29,311	61,315	180	383	529
May	9,194	27,865	63,350	322	506	654
Jun	12,422	22,777	53,557	561	645	726
Jul	14,840	21,753	30,452	589	662	725
Aug	13,067	18,593	24,007	502	570	657
Sep	12,303	16,575	24,742	356	409	448
Oct	8,214	12,004	15,679	169	218	267
Nov	11,501	14,299	22,405	68	86	110
Dec	13,752	29,479	68,604	61	80	102

Flows are in cfs and monthly flows from 1995–2004.
Source: USGS website. Sacramento River and Putah Creek flows were from the CDEC website.

Land Use Patterns

Although significant differences in irrigated acres and crop types are apparent among available information sources, the relative proportions of each crop type were similar. The DWR land use data were used for the purposes of this report because they were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops, which may create a small amount of crossover.

The cities of Davis, Woodland, Vacaville, and West Sacramento make up the major urban land use in the Solano-Yolo Subwatershed (see gray shaded area in Figure 3-18). Table 3-39 shows the land use acreage according to DWR land use data for the Solano-Yolo Subwatershed. Commercial, industrial, residential, urban, and urban landscape combined equal approximately 4.8% of the subwatershed. The largest portion of the subwatershed is native vegetation, making up 31%.

Irrigated agriculture makes up a large portion of the Solano-Yolo Subwatershed, equaling approximately 58% of land use, and consists of citrus, subtropical, deciduous fruits and nuts, field crops, grain and hay crops, pasture, rice, semiagriculture, nursery, berry crops, and vineyards. The largest single irrigated agriculture commodity is field crops, which make up approximately 18% of the 58% of irrigated agriculture. Field crops are followed closely by grain and hay crops, which make up about 14% of the irrigated agriculture. One important crop within the irrigated agriculture is pasture, which makes up almost 10% of irrigated agriculture, but which may or may not be irrigated or may be irrigated only seasonally. The last major irrigated agriculture commodity in the Solano-Yolo Subwatershed is truck, nursery, and berry crops, which make up approximately 8%.

Table 3-39. Land Use Acreage according to DWR Land Use Data for the Solano-Yolo Subwatershed

Land Use	Acres	Percent Total
Agriculture		
Citrus and Subtropical	291	0.03
Deciduous Fruits and Nuts	37,818	4.20
Field Crops	159,486	17.73
Grain and Hay	122,221	13.59
Idle	14,207	1.58
Pasture	86,503	9.62
Rice	14,414	1.60
Semiagricultural and Incidental	5,668	0.63
Truck, Nursery, and Berry Crops	67,979	7.56
Vineyards	14,091	1.57
Entry Denied	2,697	0.30
Subtotal	525,375	58.41
Urban		
Urban—unclassified	27,183	3.02
Urban Residential	4,942	0.55
Urban Landscape	1,891	0.21
Commercial	1,772	0.20
Industrial	7,004	0.78
Vacant	7,880	0.88
Subtotal	50,672	5.64
Native		
Native Classes Unsegregated	578	0.06
Native Vegetation	282,739	31.43
Barren and Wasteland	1,325	0.15
Riparian Vegetation	13,773	1.53
Water Surface	25,076	2.79
Subtotal	323,491	35.96
Total	**899,539**	**100**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Solano-Yolo Subwatershed. Table 3-40 lists the beneficial uses of Lower Putah Creek (Lake Berryessa to Yolo Bypass).

Table 3-40. Beneficial Uses by River Sub-Areas

Beneficial Uses	Lower Putah Creek (Lake Berryessa to Yolo Bypass)
Municipal & Domestic	E
Irrigation	E
Stock Watering	E
Process	
Service Supply	
POW (Power)	
Rec-1	E
Rec-2	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	P
Migration—Warm	
Migration—Cold	
Spawning—Warm	E
Spawning—Cold	
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing, U = Undefined.
Rec-1 is contact and canoeing or rafting, and Rec-2 non-contact.
Source: Sacramento San Joaquin River Basin Plan; RWQCB web site.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. The Sacramento River and Putah Creek are listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. Identified sources of impairment in the Solano-Yolo Subwatershed are agricultural and resource extraction (mining).

According to the CWA Section 303(d) list of water quality–impaired rivers, the Sacramento River (from Knights Landing to the Delta) is listed as impaired for diazinon, mercury, and unknown toxicity. Putah Creek is listed as impaired for mercury. Table 3-41 contains the TMDL priority status for the Sacramento River and Putah Creek. Potential sources of the impairments are considered to be agriculture and resource extraction.

Table 3-41. Impaired Status by River Sub-Areas

Watershed/Subwatershed	Pollutant	Potential Sources	TMDL Priority	Estimated Size Affected
Sacramento River (Knights Landing to Delta)	Diazinon	Agriculture	High	16 Miles
	Mercury	Resource Extraction	Medium	
	Unknown Toxicity	Unknown Source	Low	
Lower Putah Creek	Mercury	Resource Extraction	Low	28 miles

Data obtained from 2002 CWA Section 303(d) List of Water Quality Limited Segments.
Source: RWQCB website or Geo WBS GIS.

Water Quality

Lower Putah Creek is impaired for mercury in its lower reach below Lake Solano and has an affected area of 28 miles (Central Valley Water Board). Lake Solano has a low TMDL priority. The Sacramento River (from Knights Landing to the Delta) is impaired for diazinon, mercury, and unknown toxicity. Various state and federal water quality criteria for diazinon and chlorpyrifos are shown in Table 3-42 below. The Basin Plan identifies narrative criteria for toxicity in surface waters and states that all waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.

Table 3-42. Water Quality Criteria for Diazinon and Chlorpyrifos

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)		
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL or DWEL	CDHS	CTR
Diazinon	0.05	0.08	0.1	0.1	0.6001	6	
Mercury (total)	N/A	N/A	0.77	1.4	2.0 (inorganic)	2.0 (inorganic)	0.05

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. Chronic and acute criteria for zinc and copper are hardness dependent. CDHS criteria for copper are the primary MCL. CTR chronic and acute criteria are equal to EPA criteria. The EPA has established a tissue residue criterion of 0.3 mg methylmercury/kg fish (EPA 2001).
Sources: EPA 2003; Siepman and Finlayson 2000.

Water quality monitoring along the creek indicates that creek water near Winters has been degraded. The BDAT website (http://bdat.ca.gov) contains mercury data for Putah Creek at Mace Boulevard, which is near Davis. Of 22 samples during 1995 to 2001 two samples (9.1%) were above the CTR criteria of 0.05 µg/L. The mercury data for Putah Creek at Mace Blvd are shown in Table 3-43 below. The Sacramento River at Freeport water quality is discussed in more detail in the American River Subwatershed section.

Table 3-43. Mercury Data for Putah Creek at Mace Boulevard

	Mercury (µg/L)
Earliest Date	Jan-95
Latest Date	Oct-06
Count	22
Minimum Concentration	0.0016
Average Concentration	0.0403
Maximum Concentration	0.485
% Exceedances	9.1

Source: The BDAT website: <http://bdat.ca.gov>.

Sacramento River Basin—American River Subwatershed

General Description

The American River Subwatershed is located in northeastern California, touches Nevada and Sutter Counties to the north, and El Dorado County and Amador County to the south. To the immediate east are the Sierra Nevada Mountains and to the west are Yolo County and the Sacramento River. The subwatershed is approximately 1,805,605 acres. Figure 3-11 delineates the American River Subwatershed. The major hydrologic features in the area include the Sacramento River, the American River, Morrison Creek, and Arcade Creek. Several other small subsheds are located in the American River Subwatershed, including the Auburn Ravine, Markham Ravine, Coon Creek, Pleasant Grove, and Curry Creek in Placer County. These subsheds flow to the Eastside and Cross Canal in Sutter County, which flows straight into the Sacramento River near Verona.

Differences in annual precipitation averages throughout the watershed correspond with variations in elevation. Near the headwaters, where elevation is highest, the annual average precipitation ranges from 65 to 75 inches. At the middle elevations the amount of annual average precipitation drops to between 35 and 45 inches. At the watershed’s lowest elevations, near Folsom Reservoir, precipitation is even lower, ranging from 22.5 to 27.5 inches per year (CDF 1990).

American River/Sacramento River

The natural drainage in the northern Sacramento County portion of the Subwatershed generally flows east to west or to the southwest. The American River, the major river in the subwatershed, flows east to west except for a small portion upstream of Folsom Lake that flows north to south. The American River consists of the North Fork American River (NFAR), Middle Fork American River (MFAR), and the South Fork American River (SFAR). In October of 1968 the Wild and Scenic Rivers Act was passed to protect designated rivers from degradation. The North Fork American River, and the Lower American are listed as a wild and scenic river under the Wild and Scenic River Act. The designated areafor the Lower American River is from the Mouth to Nimbus Dam. The designated area for the NFAR is from a point 0.3 miles above Heath Springs downstream to a point 1,000 feet upstream of the Colfax-Iowa Hill Bridge.

The SFAR reaches from the headwaters at the Sierra Nevada Mountains’ crest to the convergence with Folsom Reservoir and drops in elevation from 9,900 feet to 480 feet. At 537,166 acres (about 840 square miles) the SFAR watershed includes 81 topographically delineated sub-basins, encompassing all of the tributaries that drain into the SFAR and corresponding portion of Folsom Reservoir (SVWQC 2004). The northern edge of the watershed is the ridgeline separating the American River Middle and South Fork watersheds. The southwestern boundary roughly parallels Pleasant Valley Road near Shingle Springs. The southeastern boundary generally parallels Iron Mountain Road. The eastern boundary is Carson Pass located in Alpine County, and the western boundary includes portions of El Dorado Hills and extends to the El Dorado County line.

About 40% of the full length of the SFAR above Folsom Reservoir is at an elevation greater than 5, 000 feet (El Dorado County Management Plan). At the higher elevations precipitation is often in the form of snow, with the maximum accumulation usually occurring about April 1 (SVWQC 2004). Areas above 6,000 feet maintain their snowpack until warmer weather causes snowmelt (usually March–June). The NFAR is similar in nature to the SFAR and the MFAR in that much of the river is at a higher elevation until it’s confluence with Folsom Lake.

The Sacramento River flows year-round because of flow releases upstream at Shasta Dam and Oroville Dam. Most creeks in the Sierra Nevada Mountains and the Sacramento Valley are intermittent. However, Dry Creek, Arcade Creek, Willow Creek, Morrison Creek, and Buffalo Creek flow year-round. Flood protection along many of the rivers and channels is provided by levees, including those along the Sacramento and American Rivers. Tidal influence from the Delta can be measured as far north as the city of Sacramento on the Sacramento River. In the middle to lower part of the subwatershed, Morrison Creek, Lost Slough, and Snodgrass Slough join the Sacramento River. Monthly average flows for the Sacramento River and the American River from 1995 to 2004 are in Table 3-44 below. Flows for the SFAR at Chili Bar (CDEC station CBR) are included in Table 3-44 below.

Winter flows are dominated by discharges from wastewater treatment facilities and runoff from rainfall events. Summer flows are dominated by irrigation water deliveries to farms, golf courses, and small ranches on the valley floor.

Arcade/Morrison/Elder Creek

Arcade Creek is located primarily in western Sacramento County. Approximately 80% of Arcade Creek's 10,240-hectare (25,600-acre) watershed is urbanized. Once intermittent, the creek now maintains summer flows from urban runoff, and during periodic winter storms swells to flood stage. Morrison Creek drains through the south Sacramento area and is primarily city runoff. Elder Creek is part of the upstream watershed of Morrison Creek and both drain into the Sacramento River. The USGS maintains flow-monitoring stations for both Arcade Creek and Morrison Creek. However, no flow station is available for Elder Creek on either USGS or CDEC websites. Monthly average f lows for Arcade and Morrison Creek can be found in Table 3-44 below.

Chicken Ranch/Strong Ranch Slough

Chicken Ranch Slough has approximately 8 miles of drainage and drains into the lower American River prior to the American River confluence with the Sacramento River. Strong Ranch Slough has approximately 6.4 miles of drainage and also drains into the Lower American. Neither the USGS website nor the CDEC website shows a flow station for Chicken Ranch or Strong Ranch Slough.

Auburn/Markham Ravine

The Auburn Ravine begins in the foothills of the Sierra Nevada Mountains northeast of Auburn. Basin elevation ranges from 30 to 1,000 feet above sea level. The flow of the ravine passes through rural residential areas, into part-time agricultural areas, and finally into urban Auburn. The ravine, well contained in a natural channel, passes through multiple culverts throughout the city then passes through western Placer County, into the city of Lincoln and eventually into rural agricultural lands.

The Markham Ravine originates in the low elevation hills northeast of Lincoln and has a poorly defined channel. This subshed passes through industrial, light industrial, and rapidly urbanizing areas located on the western side of Lincoln (SVWQC 2004).

Coon Creek

This creek begins close to Clipper Gap and receives water mainly from two intermittent tributaries, Dry Creek and Orr Creek. The two creeks merge to form

Coon Creek about 1 mile west of State Route (SR) 49. Coon Creek does not pass through the most urbanized portion of the City of Auburn. Discharge from Placer County's wastewater treatment plant on Joeger Road flows into Rock Creek and then into Dry Creek, which in turn provides Coon Creek with continuous flow. The stream continues through rural agricultural areas until near McCourtney Road. The USGS does not maintain a flow station on Coon Creek.

Folsom Lake

Folsom Dam was constructed in 1956 and is located approximately 30 river miles upstream of the American River's confluence with the Sacramento River. Folsom Dam is 1,400 feet long and 340 feet high. Folsom Dam regulates flow for the entire American River watershed and has an estimated capacity of 975,000 acre-feet (Geotechnical Consultants 2003). Folsom Lake provides both flood protection and recreational opportunities for the Sacramento metropolitan area.

Table 3-44. Monthly Average Flows on the Sacramento River, American River, Arcade Creek, and Morrison Creek from 1995 to 2004 (cubic feet per second)

	Sacramento River at Freeport			American River at Fair Oaks			Arcade Creek at Del Paso			Morrison Creek near Sacramento*			South Fork American River at Chili Bar		
Month	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	17,251	43,997	87,116	1,470	6,698	31,245	7	61	181	11	40	93	627	1,351	2,476
Feb	18,232	52,203	80,867	1,507	7,298	14,656	2	80	232	11	98	281	455	1,813	3,600
Mar	21,316	44,644	74,782	1,507	5,513	18,157	4	17	27	11	19	27	693	1,857	3,273
Apr	12,178	29,311	61,315	1,594	4,472	8,408	2	15	35	7	12	21	942	1,928	3,332
May	9,194	27,865	63,350	1,805	5,499	13,816	2	11	28	5	9	17	1,075	2,392	3,709
Jun	12,422	22,777	53,557	2,230	4,083	7,601	1	2	4	3	5	7	323	1,425	2,513
Jul	14,840	21,753	30,452	2,110	3,941	10,562	1	2	3	4	6	7	309	856	1,211
Aug	13,067	18,593	24,007	1,558	2,369	4,007	2	3	9	4	6	9	285	1,043	1,717
Sep	12,303	16,575	24,742	1,558	2,369	4,007	1	2	7	3	5	9	200	912	1,367
Oct	8,214	12,004	15,679	1,268	2,130	2,765	1	5	17	4	7	11	127	469	698
Nov	11,501	14,299	22,405	964	2,236	3,483	2	17	31	6	13	17	274	589	1,064
Dec	13,752	29,479	68,604	1,454	3,515	14,008	0	47	101	3	25	52	497	862	1,254

* Morrison Creek flows are 1998–2004.
Relevant data were not available for the Auburn Ravine, Coon Creek, or the Markham Ravine. Flows are in cfs.
Source: USGS website. SFAR monthly average flows are from 1997 to 2004. Data for SFAR obtained from CDEC website.

Land Use Patterns

Although significant differences in irrigated acres and crop types were apparent between available information sources, the relative proportions of each crop type were similar. The DWR land use data were used for the purposes of this report. They were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

A significant amount of land in the American River Subwatershed is privately owned. Property held publicly includes the Western Regional Sanitary Landfill near Fiddyment Road and the small U.S. Air Force property adjacent to Moore Road. Mixed land use of rice, irrigated and non-irrigated pasture, fruit tree crops, and livestock surrounds four cities (Roseville, Rocklin, Lincoln, Auburn) and four unincorporated urbanized areas (Granite Bay, Newcastle, Loomis, and Penryn) (SVWQC 2004). (Figure 3-19.)

The largest urban areas are the cities of Sacramento, Citrus Heights, Folsom, and Elk Grove. The primary metropolitan areas of the subwatershed are in the downtown areas of those cities and along major transportation corridors, including Interstate 5 to the north and south of Sacramento, Highway 99 to the south, Business 80 to the north, and Highway 50 east toward Folsom. Urban land use, which is a combination of DWR land use types commercial, industrial, residential, urban, urban landscape and FRAP land use type urban, makes up the second largest acreage in the subwatershed, consisting of 12.7% (see Table 3-45 below).

Irrigated agriculture makes up approximately 9.6% of the subwatershed. The largest irrigated agricultural commodity is rice, accounting for 4.1% of land use acres, followed by pastureland at 1.9%. It is important to note, however, that pasture may not all be irrigated land, and it is impossible to know exactly how much is irrigated without a detailed survey. Field crops and grain crops together account for 2.1% of irrigated land, and deciduous fruits and nuts account for 0.37%. The remaining irrigated land uses are citrus, truck, nursery and berry crops, vineyards, and semiagriculture (FRAP land use type) which together account for 0.41% of total land use acres. Table 3-45 contains DWR and FRAP land use data by land use type.

Table 3-45. Land Use Acreage according to DWR and FRAP Land Use Data for the Placer–Northern Sacramento Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	412	0.023
Deciduous Fruits and Nuts	6,684	0.370
Field Crops	20,014	1.108
Grain and Hay	18,097	1.002
Idle	13,736	0.761
Pasture	34,536	1.913
Rice	73,289	4.059

DWR Land Use Type	Acres	Percent Total
Semiagricultural and Incidental	3,092	0.171
Truck, Nursery, and Berry Crops	2,935	0.163
Vineyards	961	0.053
Subtotal	173,757	9.62
Urban		
Urban—unclassified	145,510	8.059
Urban Landscape	7,115	0.394
Urban Residential	21,500	1.191
Commercial	2,173	0.120
Industrial	10,351	0.573
Vacant	22,790	1.262
Subtotal	209,438	11.60
Native		
Native Vegetation	720,694	39.914
Barren and Wasteland	8,363	0.463
Riparian Vegetation	6,469	0.358
Water Surface	15,831	0.877
Subtotal	751,356	41.61
FRAP Land Use Type		
Agriculture	6,180	0.342
Barren	27,148	1.504
Conifer	397,516	22.016
Hardwood	106,395	5.892
Herbaceous	33,484	1.854
Shrub	59,930	3.319
Water Surface	15,609	0.864
Wetland	4,992	0.276
Urban	19,805	1.097
Subtotal	671,058	37.17
Total	**1,805,609**	**100**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the American River Subwatershed. Table 3-46 lists the beneficial uses of the American River: from the South Fork Source to Placerville, South Fork Placerville to Folsom Lake, Flosom Lake, and Folsom Dam to the Sacramento River.

Table 3-46. Beneficial Uses by River Sub-Areas

	American River			
Beneficial Uses	South Fork Source to Placerville	South Fork Placerville to Folsom Lake	Folsom Lake	Folsom Dam to Sacramento River
Municipal & Domestic	E	E	E	E
Irrigation		E	E	E
Stock Watering				
Process				
Service Supply			P	E
POW (Power)	E	E	E	E
Rec-1	E	E	E	E
Rec-2	E	E	E	E
Freshwater Habitat—Warm	P	E	E	E
Freshwater Habitat—Cold	E	E	E	E
Migration—Warm				E
Migration—Cold				E
Spawning—Warm			E	E
Spawning—Cold	E			E
Wildlife Habitat	E	E	E	E
Navigation				

P = Potential, E = Existing, U = Undefined

Rec-1 is contact and canoeing or rafting and Rec-2 is non-contact.

Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards, or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Natomas East Main Drain Canal and the American River are listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. Identified sources of impairment in the American River and the Natomas East Main Drain Canal are agricultural and resource extraction (mining), and urban runoff/storm sewers.

According to the CWA Section 303(d) list of water quality–impaired rivers, the Natomas East Drain (downstream of Arcade Creek) is impaired for diazinon and polychlorinated biphenyls (PCBs), and the Natomas East Drain (Upstream of Arcade Creek is listed as impaired for PCBs. The American River in the same subwatershed is 303(d) listed as impaired for mercury and unknown toxicity. Arcade Creek is listed as impaired for chlorpyrifos, diazinon, and copper, and Morrison Creek is listed as impaired for diazinon. Elder Creek, Chicken Ranch Slough, and Strong Ranch Slough are all listed as impaired for diazinon and chlorpyrifos, with high TMDL priorities. Lastly, the Sacramento River from

Knights Landing to the Delta is listed as impaired for diazinon, mercury, and unknown toxicity. Table 3-47 contains the TMDL priority status for both the Natomas East Drain and the American River. Potential sources of the following impairments are considered to be agriculture, agriculture grazing, silviculture, and highway/bridge construction.

Table 3-47. Impaired Status by River Sub-Areas

Watershed/Subwatershed	Pollutant	Potential Sources	TMDL Priority	Estimated Size Affected
Sacramento River (from Knights Landing to Delta)	Diazinon	Agriculture	High	16 miles
	Mercury	Resource extraction (abandoned mines)	Medium	16 miles
	Unknown toxicity	Source unknown	Low	16 miles
Arcade Creek	Chlorpyrifos	Urban runoff/storm sewers	High	9.9 miles
	Diazinon	Agriculture aerial deposition Urban runoff/storm sewers	High	9.9 miles
	Copper	Urban runoff/storm sewers	Low	9.9 miles
Morrison Creek	Diazinon	Agriculture aerial deposition Urban runoff/storm sewers	High	21 miles
Natomas East Drain Canal (Downstream of Arcade Creek)	Diazinon	Agriculture aerial deposition Urban runoff/storm sewers	Medium	3.5 miles
	PCBs	Industrial point sources, agriculture Urban runoff/storm sewers	Low	3.5 miles
Natomas East Main Canal (Upstream of Arcade Creek)	PCBs	Industrial point sources, agriculture Urban runoff/storm sewers	Low	12 miles
Elder Creek	Diazinon	Urban runoff/storm sewers	High	11 miles
	Chlorpyrifos	Agriculture aerial deposition Urban runoff/storm sewers	High	11 miles
Chicken Ranch Slough	Diazinon	Agriculture aerial deposition Urban runoff/storm sewers	High	8 miles
	Chlorpyrifos	Urban runoff/storm sewers	High	8 miles
Strong Ranch Slough	Diazinon	Agriculture aerial deposition Urban runoff/storm sewers	High	6.4 miles
	Chlorpyrifos	Urban runoff/storm sewers	High	6.4 miles
American River	Mercury	Resource extraction (abandoned mines)	Low	27 miles
	Unknown toxicity	Source unknown	Low	27 miles

Source: CWA Section 303(d) list.

Water Quality

Surrounding land uses largely affect surface water quality, with both point-source and nonpoint-source discharges contributing contaminants to surface waters. The Sacramento and American Rivers are currently dominated by rural, residential, and agricultural land uses. Pollutant sources in urban areas typically include parking lots and streets, rooftops, disturbed soils at construction sites, and landscaped areas. Other contaminants in urban runoff include sediment, hydrocarbons, metals, pesticides, bacteria, and trash. Runoff from agricultural and landscaped areas is characterized by constituents such as fertilizers, herbicides, and pesticides, and often contains bacteria, high nutrient content, and dissolved solids. Diazinon and chlorpyrifos represent contaminants of high TMDL priority. Diazinon and chlorpyrifos acute and chronic criteria for various agencies are listed in Table 3-48 below.

Table 3-48. Water Quality Criteria for Diazinon and Chlorpyrifos

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)	
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL or DWEL	CDHS
Diazinon	0.05	0.08	0.10	0.10	0.6001	6.000
Chlorpyrifos	0.014	0.02	0.041	0.083	20.001	90.00

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. Chronic and acute criteria for zinc and copper are hardness dependent. CDHS criteria for copper are the primary MCL. CTR chronic and acute criteria are equal to EPA criteria.

Sources: EPA 2003; Siepman and Finlayson 2000.

The American River (from Nimbus Dam to the confluence with the Sacramento River) has fairly good water quality with the exception of mercury levels as a result of abandoned resource extraction mines. The American River has a low TMDL priority and an estimated affected area of approximately 27 miles. Mines may leach mercury into ground and surface water. An unknown toxicity also impairs the river, but its source is unknown.

The water quality of the Sacramento River is of low to medium quality from Keswick Dam to Knights Landing. An unknown toxicity from an unknown source is the main concern. In some parts, this unidentified pollutant may affect as much as 82 miles. The Sacramento River is listed as impaired for diazinon and has a high TMDL priority. The Sacramento River at Freeport diazinon concentrations are all under the most conservative criteria of 0.05 µg/L (DFG criteria) (see Table 3-48 above). The Sacramento River at Freeport diazinon data are in Table 3-49 below. However, it is important to note that many of the concentrations are very close to violation or just under the DFG criteria for diazinon. None of the concentrations of diazinon exceed the DFG criteria. Like the American River, the Sacramento River is also listed as impaired for mercury. Sources of mercury include abandoned mines and resource extraction. Mercury is considered to be a medium TMDL priority. As of August 2005, the Regional Water Quality Control Board released the Sacramento–San Joaquin Delta

Estuary TMDL for methyl and total mercury. This TMDL addresses mercury and assigns load allocations for the Sacramento River.

Table 3-49. Diazinon Concentrations in Sacramento River at Freeport from 1997 to 2004

	Sacramento River at Freeport	Arcade Creek near Del Paso Heights	Arcade Creek near Del Paso Heights	Strong Ranch Slough
	Diazinon (µg/L)	Diazinon (µg/L)	Chlorpyrifos (µg/L)	Diazinon (µg/L)
Earliest Date	Feb-97	Jan-97	Jan-97	Aug-72
Latest Date	Sep-04	Apr-04	Jul-04	Mar-04
Count	18	13	13	12
Minimum Concentration	0.005	0.036	0.006	0.04
Average Concentration	0.016	0.33	0.019	0.148
Maximum Concentration	0.046	0.588	0.044	0.31
% Exceedances	0	92.3	69.2	92

Source: The BDAT website: <http://bdat.ca.gov>.

The Natomas East Main Drain Canal has poor water quality and high priority for diazinon on the 303(d) impaired list. Diazinon in the Natomas East Main Drain Canal comes from aerial deposition, primarily from agricultural uses and then into urban runoff/storm sewers. In the same canal, PCBs are a pollutant, mostly coming from industrial point sources, agriculture, and urban runoff/storm sewers. Data sources for this location are not available at this time.

The Central Valley Water Board completed the diazinon TMDL for urban creeks in September of 2004. The overall water quality of Arcade Creek is relatively stressed with diazinon concentrations. However, these levels are expected to decline over the next few years because diazinon is no longer being sold. According to USGS grab samples on Arcade Creek near Del Paso Heights, 60 of the 64 (94%) samples taken between 1997 and 2004 exceeded the DFG criteria of 0.05 µg/L. The pesticides in Arcade Creek come from the developed areas around the creek boundaries including golf courses and parks. In addition, two of the 64 samples exceeded the EPA-SNARL criteria for human health. Chlorpyrifos concentrations on Arcade Creek exceeded the DFG criteria 23% of the time (15 of the 64 samples), and no samples exceeded the EPA-SNARL criteria for human health. Data for Arcade Creek can be found in Table 3-50 below. Like Arcade Creek, Morrison Creek is stressed with elevated levels of diazinon and is listed as impaired for diazinon with a high TMDL priority. The USGS website does not contain water quality samples for Morrison Creek, and therefore diazinon concentrations are unknown.

Table 3-50. Diazinon and Chlorpyrifos Data on Arcade Creek near Del Paso Heights from 1997 to 2004

Date	Diazinon Concentration (µg/L)
1/13/1997	0.545
4/10/1997	0.506
6/13/1997	0.438
1/9/1998	0.208
3/9/1998	0.420
1/17/2001	0.268
6/18/2001	0.386
2/8/2002	0.396
2/13/2003	0.331
4/18/2003	0.588
1/20/2004	0.036
3/26/2004	0.170
4/29/2004	0.218
	Chlorpyrifos Concentration (µg/L)
1/13/1997	0.044
1/29/1997	0.026
3/7/1997	0.017
2/17/1998	0.024
3/9/1998	0.024
1/17/2001	0.006
4/10/2001	0.009
2/8/2002	0.020
4/10/2002	0.016
2/13/2003	0.010
4/18/2003	0.022
3/26/2004	0.021
7/30/2004	0.006

Source: USGS website. Accessed on 9/15/2005.

Elder Creek and Chicken Ranch Slough are listed as impaired for diazinon and chlorpyrifos with a high TMDL priority. The USGS website shows no water quality samples for Elder Creek or Chicken Ranch Slough. However, the USGS website does contain water quality samples for Strong Ranch Slough, also listed as impaired for diazinon and chlorpyrifos. USGS samples are relatively outdated and do not contain chlorpyrifos samples, only diazinon samples. As these data are old, *in-situ* conditions could have changed drastically. Results showed that between 1972 and 1974 11 of 12 samples exceeded the DFG criteria of 0.05 µg/L, resulting in a 92% exceedance rate. Data for Strong Ranch Slough are in Table 3-51 below.

Table 3-51. Diazinon Concentrations at Strong Ranch Slough

Date	Concentration µg/L
8/28/1972	0.08
9/26/1972	0.20
9/26/1972	0.15
11/5/1973	0.19
11/5/1973	0.07
11/6/1973	0.10
11/13/1973	0.08
11/13/1973	0.10
11/13/1973	0.04
2/28/1974	0.14
2/28/1974	0.31
3/1/1974	0.31

Source: USGS website. Accessed on 9/15/2005.

The general water quality of the Auburn and Markham Ravines that feed Folsom Lake is excellent, with high levels of DO and low temperatures for natural habitat. There is a history of gold mining, and the use of mercury to extract gold-bearing ore appears to be the cause of elevated levels of mercury in the upstream watershed. Folsom Lake is not listed by CWA 303(d), but the American River is. Another water quality issue can be traced to Folsom Lake, where boating activities and two-stroke engines can result in methy tertiary-butyl ether (MTBE) impacts and other fuel-related hydrocarbons affecting water quality in the lake.

San Joaquin River Watershed—Cosumnes River Subwatershed

General Description

The Sacramento-Amador Subwatershed is located in central California (Sacramento and Amador Counties) within the Great Valley and Sierra Nevada geomorphic provinces. The Subwatershed borders are San Joaquin and Calaveras Counties on the south and northern Sacramento and El Dorado Counties on the north. Sacramento County and Amador County land borders the rest of the subwatershed. The subwatershed is approximately 492,358 acres and extends from the confluence of the Cosumnes and Mokelumne Rivers in the west into the foothills of the Sierra Nevada Mountains. At its southernmost end, the watershed empties into the Mokelumne River. Elevation ranges from 80 to 4,462 feet above sea level (SVWQC 2004). (Figure 3-20.)

The natural drainage in the Sacramento-Amador Subwatershed generally flows east to west or to the southwest. The San Joaquin River and its tributaries, the

Mokelumne River and Dry Creek, and the Jackson Creek Watershed (in Amador County) are the southern borders of the watershed.

The Subwatershed has a Mediterranean type climate, characterized by dry summers and cool, moist winters. Sacramento County has an average annual precipitation that ranges from 15 to 24 inches. Rainfall totals increase as elevation increases in the eastern and northeastern parts of Sacramento County. The annual rainfall at the confluence of the Mokelumne and the Cosumnes Rivers, the southwest portion of the subwatershed, averages 15 to 17 inches while Folsom, in the northeast, averages 24 inches. Approximately 80% of annual rainfall occurs between November and March (SVWQC 2004).

Cosumnes River

The Cosumnes River watershed ranges from approximately 7,600 feet in elevation at its source to 800 feet. The Cosumnes River watershed boundary is derived from the USGS's federal hydrologic units. The Upper Cosumnes River watershed is located in the southern portion of El Dorado County and the northwestern portion of Amador County. The large majority, about 254,541 acres, of the watershed is in El Dorado County. In the Cosumnes River watershed, there are areas of both private and public lands. Depending on their locations, the properties fall under either the Amador County or El Dorado County general plans' protocols. The El Dorado National Forest or the Bureau of Land Management administers the public lands in the watershed. The Cosumnes River extends northeast through the watershed into Amador and El Dorado Counties. The two main tributaries to the Cosumnes River are Deer Creek and Laguna Creek. The Cosumnes River splits into the Lower Fork, Middle Fork and Upper Fork; the Lower Fork is in Amador County.

Portions of the virtually unregulated Cosumnes River are dry in the summer as many creeks in the Sierra Nevada Mountains and the Sacramento Valley are intermittent. During the winter, levees provide flood protection along the Cosumnes River in the lower watershed.

Laguna Creek is ephemeral with several months of little to no flow. Because of this low/intermittent flow and lack of available data, Laguna Creek will not be further analyzed in this report. Flows in the Cosumnes River at Michigan Bar (station number 11335000) are included in Table 3-52 below.

Table 3-52. Flows for the Cosumnes River and Laguna Creek, 1995–2004 (cfs)

	Laguna Creek (Station 11336585)			Cosumnes River (Station 11335000)		
	Min	Mean	Max	Min	Mean	Max
Jan	4	46	206	140	1,516	7,129
Feb	2	75	254	255	1,520	3,490
Mar	0	9	22	346	1,431	4,515
Apr	0	3	9	403	996	2,182
May	0	1	2	171	831	2,202
Jun	0	1	3	43	305	1,084
Jul	0	1	2	14	86	263
Aug	0	1	2	6	32	87
Sep	0	1	2	5	24	67
Oct	0	0	1	9	32	65
Nov	0	2	4	32	82	188
Dec	0	19	92	70	448	2,599

Source: USGS website.

Land Use Patterns

Although significant differences in irrigated acres and crop types were apparent among available information sources, the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because they were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

The majority of land use in the Cosumnes River Subwatershed is classified as native vegetation, which makes up approximately 84% of the acreage. Native vegetation also includes riparian vegetation, annual grassland, conifer, hardwood, herbaceous, shrub, and wetland (Table 3-53). The surrounding area is relatively rural and urbanization is minimal, making up less than 6% of the subwatershed. Total irrigated agriculture is classified as citrus and subtropical, deciduous fruits and nuts, field crops, grain/hay crops, pasture, rice, semiagriculture and incidental agriculture, truck, nursery and berry crops, vineyards, and agriculture. Combined, irrigated agriculture makes up the second largest portion of the Sacramento-Amador Subwatershed, totaling approximately 9.8% of land use. Figure 3-32 shows land use for the entire subwatershed as delineated by the DWR land use database. The majority of the land is clearly native vegetation as defined above; however, agriculture and, to a lesser extent, urban land use are also highly visible land use types. In addition, the 9.8% of irrigated agriculture may be a very conservative value based on the fact that pasture (the largest portion classified in this category) may or may not be irrigated land.

Table 3-53. Land Use Acreage according to DWR and FRAP Land Use Data for the Cosumnes River Subwatershed

DWR Land Use Types	Acreages	Percent Total
Agriculture		
Citrus and Subtropical	209	0.03
Deciduous Fruits and Nuts	2,388	0.29
Field Crops	16,658	2.04
Grain and Hay	4,288	0.52
Idle	2,327	0.28
Pasture	22,565	2.76
Rice	186	0.02
Semiagricultural and Incidental	2,511	0.31
Truck, Nursery, and Berry Crops	2,250	0.28
Vineyards	24,051	2.94
Subtotal	77,432	9.47
Urban		
Urban—unclassified	5,471	0.67
Urban Landscape	762	0.09
Urban Residential	15,888	1.94
Commercial	738	0.09
Industrial	4,433	0.54
Vacant	2,564	0.31
Subtotal	29,856	3.65
Native		
Native Vegetation	366,454	44.83
Barren and Wasteland	1,444	0.18
Riparian Vegetation	5,558	0.68
Water Surface	3,701	0.45
Subtotal	377,158	46.14
FRAP Land Use Types		
Agriculture	2,298	0.28
Barren and Wasteland	503	0.06
Conifer	165,820	20.29
Hardwood	91,608	11.21
Herbaceous	39,809	4.87
Shrub	19,488	2.38
Urban	11,943	1.46
Water	1,043	0.13
Wetland	413	0.05
Subtotal	332,924	40.73
Total	**817,370**	**100**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Cosumnes River Subwatershed. Table 3-54 lists the beneficial uses of the Cosumnes River from its source to the Delta.

Table 3-54. Beneficial Uses by River Sub-Areas

Beneficial Uses	Cosumnes River
Municipal & Domestic	E
Irrigation	E, P
Stock Watering	E
Process	
Service Supply	
POW (Power)	P
Rec-1	E, P
Rec-2	E, P
Freshwater Habitat—Warm	E, P
Freshwater Habitat—Cold	E, P
Migration—Warm	E, P
Migration—Cold	E
Spawning—Warm	E, P
Spawning—Cold	E, P
Wildlife Habitat	E, P
Navigation	

P = Potential, E = Existing, U = Undefined.
Rec-1 is contact and canoeing or rafting, and Rec-2 noncontact.
Source: Sacramento–San Joaquin River Basin Plan or RWQCB web site.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Cosumnes Subwatershed does not include any impaired water bodies.

Water Quality

The Cosumnes River has excellent water quality in general. It is not on the 303(d) list for any stressors and is not significantly affected by large agricultural or urban sources of pollution. The Cosumnes River is one of two remaining significant free-flowing rivers from the Sierra Nevada Mountains. While some mining took place upstream, there were no lasting effects on water quality from resource extraction (USGS 2005). The pH for the Cosumnes River at Michigan Bar was outside the Basin Plan threshold in 0.735% of the samples (two of 272 samples). Specific conductance was never over the threshold in any of the 272 samples at the same location. The samples were collected approximately quarterly from October 1952 to September 1980 and approximately monthly from October 2001 to August 2004 (USGS water quality data). Because of its excellent water quality, the Cosumnes has been used in studies as a reference for unaffected water quality (USGS 2005).

San Joaquin River Basin—Delta-Mendota Canal Subwatershed

General Description

The Delta-Mendota Canal Subwatershed is bounded on the east by the San Joaquin River and on the west by the Coast Range Mountains, including Mount Diablo, which is just to the north of the subwatershed. To the north lies the San Joaquin Delta, and to the South is the Tulare Lake Basin (Figure 3-21). Six westside tributaries to the valley floor section of the San Joaquin River are considered in the Westside Drainages section. From north to south they are Del Puerto Creek, Orestimba Creek, Garzas Creek, Los Banos Creek, Mud Slough, and Salt Slough. Like the eastside tributaries, the lower portions of these watersheds are in the rich agricultural area of the San Joaquin Valley. Generally, the agriculture boundary is between I-5 and the San Joaquin River. However, there is some crossover next to I-5. The evaluation area of the Westside San Joaquin Valley Drainage Authority (WSJVDA) extends over much of the lower watersheds of these rivers, although it also includes other small channels that feed either directly into one of the tributaries or directly into the San Joaquin River. The WSJVDA breaks up the westside tributaries into six sub-areas that include: the Patterson Sub-Area, the Los Banos Sub-Area, the Dos Palos Sub-Area, the Tranquillity Sub-Area, the Grassland Drainage Sub-Area, and the Wetland Sub-Area. However, this subwatershed is described in the context of topographic drainages with political boundary discussions in each section. The Delta-Mendota Canal Subwatershed is approximately 1,276,102 acres (DWR 2005). The topography of the subwatershed has a minimum elevation of 13 feet, a mean elevation of 750 feet, and a maximum elevation of 3,802 feet (USGS 2005b).

The climate is typically Mediterranean, with wet winters and dry summers. This section will cover only channels that intersect directly one of the previously listed tributaries to the San Joaquin River.

Delta-Mendota Canal

The Delta-Mendota Canal (DMC) is part of the CVP; it starts at Tracy Pumping Plant near Tracy, California, and travels south to the Delta-Mendota Pool on the San Joaquin River. The majority of water deliveries through the DMC are for use by the San Joaquin River Exchange Contractors Water Authority (SJRECWA). The SJRWECWA consists of four irrigation districts who exchanged San Joaquin River Water for water pumped from the Delta. The water quality of the San Joaquin River is markedly different than that of the DMC.

From the Mendota Pool, water is delivered via canal to the Service Areas of the Central California Irrigation District (CCID), the Firebaugh Canal Water District, the Columbia Canal Company, and the San Luis Canal Company. San Luis Canal Company deliveries are made 22 miles downstream of the Mendota Pool at Sack Dam on the San Joaquin River. No flow is released from Sack Dam into the lower portions of the San Joaquin River, except during extreme storm events. This water is again introduced into the San Joaquin River as drainage through various westside streams and built facilities.

Del Puerto/Ingram/Hospital Creek

Del Puerto Creek is larger than Ingram and Hospital Creeks and drains down from the Del Puerto Creek Canyon and into the San Joaquin River just north of the city of Patterson. The agricultural boundary is typically I-5 to the west and the San Joaquin River to the east. Del Puerto Creek is seasonal with high flashy flows during the storm season and made up almost entirely of agriculture return flows during the dry season.

Ingram Creek and Hospital Creek are similar to Del Puerto Creek in that they are dominated by agriculture return flows during the dry season with seasonal flashy flows during the storm seasons. Hospital Creek is the northernmost creek, followed by Ingram Creek, then Del Puerto Creek. All three creeks drain into the San Joaquin River just north of the city of Patterson. Monthly average flow data for Del Puerto Creek from 1995 to 2004 are included in Table 3-55 below. The USGS website and the CDEC website do not contain flow data for Ingram Creek or Hospital Creek.

Orestimba Creek/Main Canal/Garzas Creek/ Los Banos Creek

Orestimba Creek flows are also dominated by agriculture runoff during the dry season and flashy seasonal winter flows during the storm season. Orestimba Creek flows east until it meets the San Joaquin River just south of the city of Patterson. During the dry season, the majority of Orestimba Creek flow comes from the CCID Main Canal, which spills into Orestimba approximately 2 miles upstream of the San Joaquin River. Upstream of the CCID Main Canal inflow to

Orestimba Creek, the creek is typically dry during the summer season. Along with water delivered from the Mendota Pool, where the Main Canal originates, the Main Canal also carries much of the agriculture runoff from the Garzas Creek watershed. Monthly average flow for Orestimba Creek at River Road from 1995 to 2004 is shown in Table 3-55. Los Banos Creek is similar to Orestimba and Garzas Creek and is typically dominated by agriculture drainage throughout the dry season. Flows are not available for Garzas Creek or Los Banos Creek.

Mud Slough/San Luis Drain/Newman Wasteway/ Salt Slough

Mud Slough traverses the famous Kesterson Reservoir that gained much publicity because of its selenium impairment and ultimately drains into the San Joaquin River just upstream of the Merced River confluence. The San Luis Drain is a human-made structure that empties into Mud Slough a few miles upstream from Mud Slough’s confluence with the San Joaquin River. The San Luis Drain is currently used to bypass agricultural drainage around the many wildlife refuges in the Delta-Mendota Canal Subwatershed. This bypass of agricultural drainage has effectively taken most of the agricultural drainage out of Salt Slough and delivered it to Mud Slough. During the dry season, Mud Slough flows are almost entirely composed of San Luis Drain flows. Monthly average flows for Mud Slough and the San Luis Drain from 1995 to 2004 are shown in Table 3-55 below.

The Newman Wasteway is a conveyance facility built from the DMC to the San Joaquin River as a way to evacuate the entire flow of the DMC in case of DMC failure. This structure also crosses under the CCID Outside and Main Canals, and conveys agriculture and urban drainage, as well as flood flows from storm events, to the San Joaquin River. The Newman Wasteway is just north of Mud Slough and meets the San Joaquin River downstream of Mud Slough’s confluence with the San Joaquin River. Salt Slough drains through portions of the Kesterson National Wildlife Refuge, which is separated from the Kesterson Reservoir by the San Luis Drain, and meets the San Joaquin River just upstream of Mud Slough. Monthly average flows for Salt Slough from 1995 to 2004 are also shown in Table 3-55 below.

Table 3-55. Monthly Average Flows from 1995 to 2004

	Del Puerto Creek near Patterson			Orestimba Creek at River Road			Mud Slough near Gustine			San Luis Drain (Site B)			Salt Slough at Highway 165		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	2	28	130	15	98	574	98	225	545	22	30	60	118	205	426
Feb	2	53	333	17	149	698	126	303	956	48	67	126	180	340	632
Mar	2	30	132	5	84	318	137	252	545	53	65	115	275	380	512
Apr	1	10	28	8	60	185	47	92	200	35	50	91	146	211	305
May	0	4	18	9	62	243	44	79	123	40	51	80	120	172	275
Jun	0	2	9	11	29	97	23	69	98	47	56	61	124	182	284
Jul	0	1	3	15	32	104	10	68	114	51	58	74	146	198	293
Aug	0	0	1	9	22	62	7	58	90	45	56	64	135	194	336
Sep	0	0	1	3	15	43	17	52	108	23	31	53	59	122	217
Oct	0	0	2	12	38	121	23	134	190	18	24	33	100	129	175
Nov	0	2	3	10	38	101	74	159	195	19	24	29	144	166	211
Dec	0	12	53	9	36	78	119	176	305	20	24	32	103	136	214

Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods uses aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation makes up the majority of land use for the Delta-Mendota Canal Subwatershed totaling approximately 55% of DWR coverage, and a very large portion of land use coverage in the FRAP vegetation dataset. Irrigated land makes up the next largest segment of land use in the Delta-Mendota Canal Subwatershed, totaling approximately 41%. Urban land use was calculated by combining commercial, industrial, residential, urban, and urban landscape (see Table 3-56). Generally I-5 makes up the western boundary for irrigated land, and the San Joaquin River makes up the eastern boundary. A large portion of the Delta-Mendota Canal Subwatershed extends up into the Coastal Range just west of I-5. However, there is virtually no irrigated agriculture in this portion of the watershed. Total irrigated land was calculated by combining citrus and subtropical, deciduous fruits and nuts, field crops, grain and hay crops, pasture, rice, semiagriculture, truck nursery and berry crops, and vineyards. The majority of the irrigated agricultural land use comes from field crops, which equal approximately 17.1% of the 41% of irrigated agriculture, totaling 187,274 acres of land. In addition, pastureland makes up approximately 8% of irrigated agriculture; however, pastureland may or may not be irrigated. Pastureland is followed closely by truck, nursery, and berry crops, which make up 7.4% of irrigated agriculture. (Figure 3-33.)

Table 3-56. Land Use Acreage according to DWR and FRAP Land Use Data for the Delta-Mendota Canal Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	745	0.068
Deciduous Fruits and Nuts	52,676	4.809
Field Crops	187,274	17.097
Grain and Hay	17,693	1.615
Idle	3,741	0.342
Pasture	93,061	8.496
Rice	7,760	0.708
Semiagricultural and Incidental	5,902	0.539
Truck, Nursery, and Berry Crops	80,735	7.371
Vineyards	1,388	0.127
Subtotal	450,975	35.4
Urban		
Urban—unclassified	8,118	0.741
Urban Residential	2,408	0.22
Urban Landscape	664	0.061
Commercial	398	0.036
Industrial	2,272	0.207
Entry Denied	95	0.009
Vacant	5,477	0.5
Subtotal	19,432	1.5
Native		
Native Vegetation	600,726	54.842
Riparian Vegetation	1,548	0.141
Water Surface	22,690	2.071
Subtotal	624,964	57.054
FRAP Land Use Type		
Conifer	2.5	0.0014
Hardwood	71,998.80	40.1027
Herbaceous	47,323.70	26.3589
Shrub	58,818.90	32.7616
Urban	1,382.10	0.7698
Water	9.9	0.0055
Subtotal	179,536	14.1
Total	**1,274,907**	**100**

Source: DWR 2005; CDF 2005.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Delta-Mendota Canal Subwatershed. Table 3-57 lists the beneficial uses of the DMC, Mud Slough, and Salt Slough. Other creeks in the Delta-Mendota Canal Subwatershed, such as Del Puerto and Orestimba, are not defined as having any beneficial uses.

Table 3-57. Delta-Mendota Canal Subwatershed Beneficial Uses

Beneficial Uses	Delta-Mendota Canal	Mud Slough[a] (B)	Salt Slough (B)
Municipal & Domestic	E		
Irrigation	E	L[b] (A)	E
Stock Watering	E	E	E
Industry			
Proc			
POW			
Rec-1	E	E	E
Rec-2	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold			
Migration—Warm		E	E
Migration—Cold			
Spawning—Warm			
Spawning—Cold			
Wildlife Habitat	E	E	E
Navigation			
COMM		E	E
BIOL			E
SHELL		E	E

P = Potential, E = Existing, L = Existing Limited Beneficial Uses, U = Undefined, COMM = Commercial and Sport Fishing, BIOL = Preservation of biological habitats of special significance, SHELL = Shellfish Harvesting.

[a] Mud Slough North.

[b] Elevated natural salt and boron concentrations may limit this use to irrigation of salt- and boron-tolerant crops. Intermittent low flow conditions may also limit this use.

Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired.

The affected water body and associated pollutant are then prioritized in the 303(d) list. According to the CWA Section 303(d) list of water quality–impaired rivers, Del Puerto Creek, Ingram/Hospital Creek, Mud Slough, Orestimba Creek, and Salt Slough are all listed as impaired for various pollutants. Table 3-58 below identifies each of these westside drainages, their associated pollutant, potential sources of the pollutant, the TMDL priority and the estimated size of the polluted area.

Table 3-58. Impaired Status by River Sub-Areas

Watershed	Pollutant	Potential Sources	TMDL Priority	Size
Del Puerto Creek	Chlorpyrifos	Agriculture Return Flows	Low	6.5 Miles
	Diazinon			
Newman Wasteway	Chlorpyrifos	Agriculture Return Flows	Low	8.3 Miles
	Diazinon			
Ingram/Hospital Creek	Chlorpyrifos	Agriculture Return Flows	Low	1 Mile
	Diazinon			
Mud Slough	Boron	Agriculture Return Flows	Low	13 Miles
	Electromagnetic Conductivity (EC)			
	Pesticides			
	Selenium		Medium	
	Unknown Toxicity		Low	
Orestimba Creek (above Kilburn Road)	Azimphos-methyl	Agriculture Return Flows	Medium	9.1 Miles
	Chlorpyrifos		Medium	
	DDE (historical ag use breakdown from DDT)		Low	
	Diazinon		Medium	
Orestimba Creek (below Kilburn Road)	Azimphos-methyl	Agriculture Return Flows	Medium	2.7 Miles
	Chlorpyrifos		Medium	
	DDE (historical ag use breakdown from DDT)		Low	
	Diazinon		Medium	
	Unknown Toxicity		Low	
Salt Slough (Upstream from confluence with San Joaquin River)	Boron	Agriculture Return Flows	Low	17 Miles
	Chlorpyrifos			
	Diazinon			
	Electromagnetic Conductivity (EC)			
	Unknown Toxicity			

DDE = 1, 1-dichloro-2,2'-bis-*p*-chlorophenyl-ethylene
DDT = 1, 1, 1 -trichloro-2, 2'-bis-p-chlorophenyl-ethane
Source: CWA Section 303(d).

Water Quality

The water quality in the Delta-Mendota Canal Subwatershed is representative of a large amount of agricultural practices. All the 303(d) listed impairments are associated with agriculture return flows. Diazinon and chlorpyrifos have been of particular concern in the subwatershed. These organophosphorus pesticides are typically applied during the winter dormant season, with chlorpyrifos use extending into the spring. Wintertime surveys of these insecticides indicated that some of the higher concentrations occur in some of the smaller tributaries (USGS 2002b) and that concentrations in precipitation were very high (USGS 2003). River concentrations of these chemicals tend to be highest during the beginning of a storm event, which is also referred to as the “first flush” storm event (USGS 2003).

The Central Valley Water Board adopted the San Joaquin River TMDL for the control of diazinon and clorpyrifos in November of 2005. The Central Valley Water Board has written a draft amendment to the Basin Plan for the control of diazinon and chlorpyrifos runoff into the lower San Joaquin River (Central Valley Water Board 2005). Diazinon and chlorpyrifos concentrations measured from 1991 through 2005 were compiled for the draft amendment and compared to proposed acute toxicity targets of 0.16 µg/L for diazinon and 0.025 µg/L for chlorpyrifos. These values are higher than the DFG acute criteria of 0.08 µg/L for diazinon and 0.02 µg/L for chlorpyrifos (Table 3-59 below).

During the past 10 years, the use of diazinon and chlorpyrifos in the subwatershed has decreased substantially (USGS 2002b). The concentration of these pesticides in the rivers has also decreased (Central Valley Water Board 2005). In recent years, pyrethroids have been replacing some organophosphate use. However, Pyrethroids tend to bind with organic material and may be more likely to be present in sediment than in water (East San Joaquin Water Quality Coalition 2004). This analysis covers only contaminants found directly in the water column.

As part of the evaluation of water quality data, the USGS water quality database (USGS website 2005a) was searched for data on the parameters and locations of concern from the 303(d) list. Data collection sites chosen for evaluation were those that had significant amounts of data. However, if no data were available for this period, older data were included. As part of this evaluation, the percent of measurements exceeding a threshold were calculated. The thresholds were generally the lowest criteria present on Table 3-59. Because the criteria selected may not be applicable to a particular water body, the purpose of this calculation is only to produce a general indicator of elevated concentrations, not to detect water quality violations. For example, a particular river may not be a source of drinking water, but exceedances of a drinking water criterion are indicative of potential problems in that watershed or downstream. For EC, the water quality criteria are variable and the threshold selected for the evaluation of data was 700 microreciprocal ohms per centimeter (µmhos/cm).

Table 3-59. Various Federal and State Criteria

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)		
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL	CDHS Action Level	CTR
Azimphos-methyl	NA	NA	NA	NA	0.01[a]	NA	NA
Diazinon	0.05	0.08	0.1	0.1	0.6	6	NA
Chlorpyrifos	0.014	0.02	0.041	0.083	20	NA	NA
Dieldrin (Group A Pesticides)	NA	NA	0.056	0.24	0.5	0.002	0.00014
Boron	NA	NA	NA	NA	600	1,000	NA
DDT	NA	NA	0.001	NA	NA	NA	0.00059
DDE	NA	NA	NA	NA	0.1[b]	NA	0.00059
Selenium	NA	NA	5	NA	50	NA	NA

[a] EPA instantaneous maximum criteria.

[b] EPA Integrated Risk Information System (IRIS) for one-in-1-million risk for cancer in drinking water

NA = indicates that the particular type of criteria is not available.

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. CTR values are the 30-day average values for drinking water for the California Toxics Rule.

Sources: EPA 2003, 2004; Siepman and Finlayson 2000; Federal Register; Central Valley Water Board 2005.

Delta-Mendota Canal

The water quality of the DMC is typical to the quality of water found in the south San Joaquin Delta. The DMC is not listed as impaired on the CWA Section 303(d) list and is not discussed in detail in this water quality analysis. It is, however, important to note that the DMC delivers Delta water that can range from 250 to 600 µmhos/cm to farmers in the San Joaquin Valley.

Del Puerto/Ingram/Hospital Creek

As stated earlier, Del Puerto, Ingram, and Hospital Creeks are impaired for diazinon and chlorpyrifos. Diazinon and chlorpyrifos samples were collected by the USGS from 1994 and 2001. Statistics were calculated for these data and included in Table 3-60. Del Puerto Creek diazinon concentrations showed a 23% rate of exceeding the chronic criterion (0.05 µg/L) from 1994 to 2001 and a 20% rate of exceeding the acute criterion (0.08 µg/L) during the same time period. Chlorpyrifos concentrations exceeded both the chronic criterion (0.014 µg/L) and the acute criterion (0.02 µg/L) 17% of the time. Ingram and Hospital Creek combined showed 46% exceedance rate (0.05 µg/L chronic) on 33 diazinon samples collected between 1991 and 1993. Thirty-four chlorpyrifos samples were collected during the same time frame for Ingram and Hospital Creek indicated a 21% exceedance (0.014 µg/L chronic) rate.

Table 3-60. Del Puerto, Ingram, and Hospital Creek Impairments

	Del Puerto Creek		Ingram and Hospital Creeks Combined	
	Diazinon (μg/L)	Chlorpyrifos (μg/L)	Diazinon (μg/L)	Chlorpyrifos (μg/L)
Earliest Date	Jun-94	Jun-94	Mar-91	Mar-91
Latest Date	Aug-01	Aug-01	Feb-93	Feb-93
Count	35	35	33	34
Minimum Concentration	0.002	0.002	0.01	0.01
Average Concentration	0.09	0.014	0.14	0.035
Maximum Concentration	1.06	0.12	1.8	0.57
% Exceedances → Chronic	23	17	46	21
% Exceedances → Acute	20	17	33	15

Orestimba/Main Canal/Garzas Creek

As stated earlier, the CWA Section 303(d) list divides Orestimba Creek into two impairment sections. The only difference in impairment between the segments of Orestimba is the unknown toxicity. There is no way of knowing what contaminant is causing this unknown impairment because there has not been a toxicity identification evaluation (TIE) done on Orestimba Creek. Kilburn Road is the point on Orestimba Creek that divides the 303(d) listed segments of the creek. The Orestimba Creek at River Road sampling location is downstream of Kilburn Road, and as a result is the most representative sampling location to define the *in-situ* water quality conditions year around. If Orestimba Creek was sampled upstream of the CCID Main Canal inflow during the dry season, it is likely there would be no flow in the Creek. The inflow from CCID Main Canal provides the majority of the flow during the dry season. In addition, the CCID Main Canal collects a large amount of flow from Garzas Creek, and the combination of flows at Orestimba Creek at River Road is representative of CCID Main Canal and Garzas Creek agriculture return flows during the dry season. It is unknown how much inflow the CCID Main Canal collects from Garzas Creek. However, Main Canal and Garzas Creek are not listed as impaired. Diazinon, chlorpyrifos, azimphos-methyl, and DDE samples were collected by the USGS and statistics were done to calculate various criteria exceedance rates and included in the following Table 3-61.

Table 3-61. Orestimba Creek at River Road Impairments

	Orestimba Creek at River Road			
	Diazinon (µg/L)	Chlorpyrifos (µg/L)	Azimphos-methyl (µg/L)	DDE (µg/L)
Earliest Date	Apr-92	Apr-92	Apr-92	Apr-92
Latest Date	Aug-04	Aug-04	Aug-04	Aug-04
Count	263	264	264	264
Minimum Concentration	0.002	0.002	0.001	0.001
Average Concentration	0.096	0.021	0.038	0.009
Maximum Concentration	3.800	0.300	0.390	0.062
% Exceedances → Chronic	24	34	NA	NA
% Exceedances → Acute	17	27	NA	NA
EPA—SNARL	3	0	NA	NA
EPA—Instantaneous Max	NA	NA	59.5	0
CDHS—Action Level	0	NA	NA	NA
CTR	0	NA	NA	100

Source: USGS website.

The USGS collected 263 diazinon samples between 1992 and 2004. Orestimba Creek diazinon concentrations exceeded the chronic criterion (0.05 µg/L) 24% of the time and the acute criterion (0.08 µg/L) 17% of the time. In addition, the maximum concentration of diazinon was 3.8 µg/L. As a result, 3% of the diazinon samples exceeded the SNARL criterion (0.6 µg/L) for cancer toxicity. The USGS collected 264 chlorpyrifos samples for the same time period. Chlorpyrifos concentrations exceeded the chronic criterion (0.014 µg/L) 34% of the time, and exceeded the acute criterion (0.02 µg/L) 27% of the time. Azimphos-methyl data were collected from 1992 to 2004. Of the 264 samples collected, 59.5% exceeded the EPA instantaneous maximum criterion (0.01 µg/L). Orestimba Creek is listed as impaired for DDE, the chemical breakdown of the organochlorine pesticide DDT. DDT is not being used anymore; however, Orestimba Creek is representative of how persistent organochlorine pesticides are in the environment. The USGS collected samples from 1992 to 2004 and 100% of the samples exceeded the CTR criterion for DDE of 0.00059 µg/L. However, no DDE samples exceeded the EPA instantaneous maximum concentration of 0.1µg/L.

Recent data (2000–2004) suggest that diazinon and chlorpyrifos concentrations are on the decline. This is likely attributable to the reduction in diazinon use as the use of pyrethroids is gaining popularity.

Los Banos Creek/Newman Wasteway

Los Banos Creek is not listed as impaired for any pollutants and is not covered in detail. However, Newman Wasteway is listed as impaired for diazinon and chlorpyrifos. The USGS collected samples for the Newman Wasteway near Gustine (see Table 3-62). Diazinon concentrations exceeded the chronic criterion 36.5% of the time and the acute criterion 27.3% of the time. Chlorpyrifos concentrations exceeded the chronic criterion 27.3% of the time and the acute criterion 18.2% of the time.

Table 3-62. Diazinon and Chlorpyrifos Concentrations for Newman Wasteway

	Newman Wasteway near Gustine	
	Diazinon (µg/L)	Chlorpyrifos (µg/L)
Earliest Date	Jun-94	Jun-94
Latest Date	1-Aug	1-Aug
Count	11	11
Minimum Concentration	0.002	0.004
Average Concentration	0.04463636	0.01254545
Maximum Concentration	0.154	0.037
% Exceedances → Chronic	36.5	27.3
% Exceedances → Acute	27.3	18.2
% Exceedances → SNARL	0	0

Source: USGS website.

Mud Slough/San Luis Drain

As stated earlier, Mud Slough is listed as impaired for boron, EC, selenium, pesticides, and unknown toxicity. In the CWA Section 303(d) list for the Central Valley, there are no other listings for "pesticides." Personal communication with Central Valley Water Board experts has indicated that pesticides are in Mud Slough, but not enough information has been collected to determine the severity of the impairment pesticides are causing.

EC data were collected at Mud Slough near Gustine from 1985 to 1994 (see Table 3-63 below). More recent data are available for Mud Slough but not in the same downloadable format. The earlier EC data are similar to recent data (see Figure 3-21a). There is no EC criterion for Mud Slough, but Mud Slough drains into the San Joaquin River, and the San Joaquin River at Vernalis has an objective of 700 µS/cm. Of the 123 EC measurements, 100% of the samples exceed the Vernalis objective. Of the 106 boron samples also collected during the same time frame, 99.1% exceeded the 600-µg/L criterion. Again during the same time frame, 171 selenium samples were collected, and 52% of the samples exceeded the chronic criterion of 5 µg/L. Mud Slough is not specifically impaired for diazinon and chlorpyrifos but rather "pesticides" because the "pesticide" impairment is not specific, and because many other watersheds are impaired for diazinon and chlorpyrifos, diazinon and chlorpyrifos were analyzed in Mud Slough. Concentrations were lower in Mud Slough than in locations such as Orestimba Creek. Diazinon samples exceed the chronic criterion (0.05 µg/L)

8.3% of the time, and the acute criterion (0.08 µg/L) 4.2% of the time. Chlorpyrifos concentration statistics were similar to diazinon concentration statistics. Chlorpyrifos concentrations exceeded the chronic criterion (0.014 µg/L) 8.33% of the time, and the acute criterion (0.02 µg/L) 4.17% of the time.

Table 3-63. Mud Slough Water Quality Data

	Mud Slough near Gustine				
	EC (µS/cm)	Boron (µg/L)	Selenium (µg/L)	Diazinon (µg/L)	Chlorpyrifos (µg/L)
Earliest Date	Jun-85	Jun-85	Jun-85	Jun-94	Jun-94
Latest Date	Sep-94	Sep-94	Sep-94	Aug-01	Aug-01
Count	123	106	171	24	24
Minimum Concentration	791	560	1	0.001	0.001
Average Concentration	2701	2712	9.9	0.024	0.007
Maximum Concentration	8220	8300	31	0.325	0.026
% Exceedances → Chronic	100	99.1	52	8.300	8.33
% Exceedances → Acute	NA	NA	NA	4.200	4.17
% Exceedances → SNARL	NA	NA	0	0.000	NA

EC exceedance criterion is based on 700 as required by criteria at San Joaquin River at Vernalis. Boron criterion is based on the 600 required by the EPA.

Sources: USGS website.

The Delta-Mendota Canal Subwatershed contains some of the most salt-affected lands in the San Joaquin Valley. According to the TMDL, the Grassland Sub-Area (the TMDLs are equivalent to the Delta-Mendota Canal Subwatershed) is the largest contributor of salt to the San Joaquin River, equaling approximately 37% of the mean annual salt load (Central Valley Water Board 2004a). Much of the salt load in Mud Slough comes from the San Luis Drain inflow (Figure 3-21a).

Salt Slough

As stated earlier, Salt Slough is listed as impaired for diazinon, chlorpyrifos, boron, and EC. EC was measured between 1985 and the present time. Although there is no EC objective in Salt Slough, downstream of Salt Slough, the San Joaquin River at Vernalis has an objective of 700 µS/cm. The average concentration of EC in Salt Slough from 1985 to 2005 was 1,951 µS/cm. Boron samples were collected from 1985 to 2000. Of 95 samples, 98% of the samples exceed the chronic criterion of 600 µg/L, and 83.2% of the samples exceeded the CDHS criterion of 1,000 µg/L. Diazinon samples were collected between 1993 and 2001. Of 49 samples, 22.4% of the samples exceed the chronic criterion of 0.05 µg/L, and 20.4% of the samples exceeded the acute criterion of 0.08 µg/L. Chlorpyrifos samples were collected from 1993 to 2000. Of 49 samples, 28.6% exceeded the chronic criterion of 0.014% µg/L, and 22.4% exceeded the acute criterion of 0.02 µg/L. (Table 3-64.)

Table 3-64. Salt Slough at Highway 165 Water Quality Data

	Salt Slough at Highway 165			
	EC (µS/cm)	Boron (µg/L)	Diazinon (µg/L)	Chlorpyrifos (µg/L)
Earliest Date	Jun-85	Jun-85	Jan-93	Jan-93
Latest Date	Jul-05	Jan-00	Aug-01	Jan-00
Count	133	95	49	49
Minimum Concentration	772	490	0.040	0.021
Average Concentration	1951	1925	0.002	0.002
Maximum Concentration	3660	4200	0.280	0.400
% Exceedances → Chronic	NA	98	22.4	28.6
% Exceedances → Acute	NA	NA	20.4	22.4
% Exceedances → SNARL	NA	NA	0	0
% Exceedances → CDHS	NA	83.2	0	NA

EC exceedance criterion is based on 700 as required by criterion at San Joaquin River at Vernalis. Boron criterion is based on the 600 required by the EPA.

Source: USGS website.

San Joaquin River Basin—
San Joaquin River Subwatershed

General Description

The upper San Joaquin River Subwatershed covers approximately 1,091,883 acres from the headwaters of the San Joaquin River high in the Sierra Nevada Mountains down to the edge of the valley floor. The subwatershed extends downstream to and includes Millerton Lake. Surrounding subwatersheds include Ahwahnee to the northwest, Valley Floor to the west, Merced River to the North, Kings River to the south, with Mono and Inyo Counties to the East. (Figure 3-22.)

The climate of the San Joaquin watershed varies greatly because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. Elevations range from 315 feet to 13,920 feet, the highest elevation in the larger San Joaquin River Basin. (USGS 2005.) The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this subwatershed.

The San Joaquin River Subwatershed includes the San Joaquin River from its sources to and including Millerton Lake and many tributaries. Millerton Lake and Friant Dam are owned and operated by Reclamation mainly for flood control and water supply purposes (Reclamation 2003). There are many other dams and reservoirs located on the Upper San Joaquin and its tributaries. PG&E and Southern California Edison operate these facilities for hydroelectric power and to meet downstream river instream flow requirements. Reservoirs upstream of Millerton Lake include Shaver Lake on Stevenson Creek, Huntington Lake on Big Creek, Florence Lake on the South Fork San Joaquin River, Lake Thomas A. Edison on Mono Creek, and Mammoth Pool Reservoir, Redinger Lake, and Kerckhoff Lake all on San Joaquin River. Bass Lake, on the North Fork of Willow Creek, can export water to the Fresno River, which is located outside of the San Joaquin River subwatershed. Inflow into Millerton Lake is influenced by these upstream reservoirs. The largest inflows occur in the late spring and early summer. On average June receives the highest average inflow, at 5,661 cfs. The lowest average inflow occurs in November at 1,077 cfs. See Table 3-65 below for average monthly flow data.

Table 3-65. Average Monthly Flow Data (cfs)

Month	Min	Mean	Max
Jan	604	2,277	9,058
Feb	604	2,317	4,303
Mar	1,375	3,117	6,277
Apr	2,294	3,488	5,911
May	2,425	4,781	8,418
Jun	2,192	5,661	11,874
Jul	1,287	3,849	11,300
Aug	1,335	2,260	4,241
Sep	1,300	1,785	2,944
Oct	712	1,166	1,789
Nov	456	1,077	1,927
Dec	511	1,292	3,540

Source: CDEC website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation is the primary land use type in the San Joaquin River Subwatershed. DWR land use type native vegetation and FRAP land use types conifer, hardwood, herbaceous, and shrub combine for 80.3% of the total land use, or 876,916.1 acres. Barren land is the second largest land use type with 179,517 acres, or 16.4%. Barren land includes DWR land use type vacant and FRAP land use type barren/other. Urban land, which includes DWR land use types commercial, residential, urban, and urban landscape, and FRAP land use type urban, is limited to 1,840 acres or 0.169%. DWR land use types deciduous fruits and nuts and semiagriculture and incidental to agriculture and FRAP land use type agriculture, combine for 205 acres of irrigated agriculture, or 0.019%. FRAP land use type wetland occupies 9,123 acres, or 0.836%. The remaining 2.2%, or 24,282 acres, of the subwatershed is water, including water surface DWR land use type and water FRAP land use type. For individual land use types and acreages see Table 3-66. (Figure 3-34.)

Table 3-66. Land Use Acreage according to DWR and FRAP Land Use Data for the San Joaquin River Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	46	0.004
Semiagricultural and Incidental	1	0.0001
Subtotal	47	0.0041
Urban		
Urban—unclassified	36	0.003
Urban Landscape	115	0.011
Urban Residential	39	0.004
Commercial	16	0.001
Vacant	29	0.003
Subtotal	235	0.022
Native		
Native Vegetation	43,540	4
Water Surface	2,322	0.2
Subtotal	45,862	4.20
FRAP Land Use Type		
Agriculture	158	0.014
Barren/Other	179,489	16.4
Conifer	606,023	55.5
Hardwood	142,167	13
Herbaceous	23,786	2.2
Shrub	61,400	5.6
Urban	1,634	0.15
Water	21,960	2
Wetland	9,123	0.83
Subtotal	1,045,740	95.7
Totals	**1,091,883**	**100**

Source: DWR 2005; CDF 2005.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the San Joaquin River Subwatershed. Table 3-67 lsits the beneficial uses of the Upper San Joaquin River from sources to Millerton Lake (including Millerton Lake).

Table 3-67. Beneficial Uses by River Sub-Areas

Beneficial Uses	Upper San Joaquin River
Municipal & Domestic	E,P
Irrigation	E
Stock Watering	E
Process	
Proc	
POW	E
Rec-1	E
Rec-2	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E,P
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	
Wildlife Habitat	E
Navigation	
COMM	
BIOL	
SHELL	

P = Potential, E = Existing, U = Undefined.
COMM = Commercial & Sport Fishing. BIOL = Preservation of biological habitats. SHELL = Shell fish harvesting.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The San Joaquin River above Friant Dam is not listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. However, it is important to note that the San Joaquin River, well downstream of Friant Dam, is impaired for boron, chlorpyrifos, DDT, diazinon, EC, group A pesticides, mercury, and unknown toxicity. For more information on these impairments see the San Joaquin Valley Floor section.

Water Quality

The water quality on the Upper San Joaquin River is excellent. As stated earlier, no 303(d) listed pollutants are associated with the Upper San Joaquin River or its tributaries. This is likely due to the native vegetation, low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this subwatershed.

San Joaquin River Basin—
San Joaquin Valley Floor Subwatershed

The San Joaquin Valley Floor Subwatershed (SJVFS) covers approximately 1,792,389 acres, and extends from north of the Stanislaus River south to the section of the San Joaquin River between Friant Dam and the Mendota Pool. From west to east it extends from the San Joaquin River to the Sierra Nevada foothills (Figure 3-23). Six east side tributaries to the San Joaquin River are considered individually in this section. From north to south they are the Stanislaus River, the Tuolumne River, the Merced River, Bear Creek, the Chowchilla River, and the Fresno River. Smaller tributaries and drains are also discussed. This subwatershed description also includes the San Joaquin River from Friant Dam to Vernalis.

The climate of the SJVFS is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing (Jones & Stokes 1998). The region averages less than 10 inches of annual rainfall. The winter snowpack, which accumulates above 5,000 feet elevation (outside of this subwatershed) primarily in the Sierra Nevada Mountains, supplies the vast majority of water in the basin. Elevations in this watershed range from approximately 0 to 1,000 feet.

The evaluation area of the East San Joaquin Water Quality Coalition (ESJWQC) extends over much of the valley floor watershed. In this watershed, water quality is also evaluated by some of the large irrigation districts. Irrigation districts that operate in this area include the South San Joaquin, Oakdale, Merced, Turlock, Modesto, Chowchilla, and Madera.

General Description

Stanislaus River

The Stanislaus River forms the northern boundary of Stanislaus and Tuolumne Counties and flows near the cities of Ripon, Riverbank, and Oakdale. It drains an area of about 1,075 square miles at its intersection with SR 99, about 15 river miles upstream of its confluence with the San Joaquin River.

The largest reservoir in the Stanislaus River watershed is New Melones, with a capacity of 2,420,000 acre-feet and a watershed area of approximately 900 square miles. Reclamation operates New Melones Reservoir on the Stanislaus River, east of Oakdale. Reclamation operates New Melones in part with the goal to meet water quality salinity standards in the San Joaquin River at Vernalis, downstream of where the Stanislaus and Tuolumne Rivers flow into the San Joaquin River.

Tulloch and Goodwin are two small reservoirs located downstream of New Melones. Between Goodwin Dam and New Melones, several canals divert water from the river, primarily for agricultural purposes. Both the Oakdale Irrigation District and the South San Joaquin Irrigation District obtain water from the Stanislaus River. Operations of New Melones Reservoir by releasing additional flow during periods of low dissolved oxygen help aid migrating fish, and is also a part of the Vernalis Adaptive Management Plan (VAMP) which requires a certain flow to make sure the San Joaquin River has enough flow for salmon smolt.

The section of the Stanislaus River that falls within the SJVFS extends from the San Joaquin River to the town of Knights Ferry, which is approximately 4 miles downstream from Goodwin Dam. The primary land use in this portion of the Stanislaus River watershed is agriculture.

Table 3-68 shows minimum, mean, and maximum monthly average flows recorded at several flow stations along the Stanislaus River from 1995 to 2004. The USGS flow records show that flows at the New Melones Powerhouse are similar to those at Goodwin Dam during November–February, but during much of the rest of the year, flows at Goodwin Dam are less than at the powerhouse because of agricultural diversions. Flows at Ripon are only slightly greater (by an average of about 100 cfs) than those below Goodwin Dam. Monthly average flows at Ripon varied between approximately 300 cfs and 6,500 cfs.

Table 3-68. Stanislaus River Flows (cfs) Measured from 1995 through 2004

	New Melones Powerhouse			Stanislaus River below Goodwin Dam			Stanislaus River at Ripon		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	82	998	5,984	236	1,100	6,005	309	1,211	6,273
Feb	199	1,696	6,683	263	1,801	6,036	367	1,940	6,499
Mar	100	1,600	3,446	213	1,315	3,180	337	1,539	3,473
Apr	1,002	2,097	2,935	601	1,145	1,936	607	1,182	1,976
May	1,939	2,580	2,988	772	1,268	2,046	834	1,356	2,067
Jun	1,970	2,460	3,137	480	934	1,798	550	1,024	1,867
Jul	1,676	2,200	3,575	264	572	1,861	414	674	1,875
Aug	1,634	2,051	3,592	226	472	1,791	318	562	1,792
Sep	1,053	1,476	2,844	184	414	1,634	278	514	1,702
Oct	–	825	2,579	339	603	1,738	332	668	1,951
Nov	–	373	909	253	364	530	311	460	962
Dec	–	671	3,152	252	676	3,300	308	706	3,194

No data at New Melones Powerhouse or below Goodwin Dam for October 1, 2004–December 31, 2004.

Source: USGS website.

Tuolumne River

The Tuolumne River flows from its headwaters in Tuolumne County through Stanislaus County. It passes by the city of Modesto and then, approximately 15 river miles from Modesto, enters the San Joaquin River. At Modesto, the Tuolumne River drains a watershed of approximately 1,900-square mile.

The largest reservoir on the Tuolumne River is New Don Pedro Reservoir, with a capacity of 2,030,000 acre-feet and a watershed of approximately 1,500 square miles (DWR 2005). It provides both flood control and water supply for the Modesto area and is jointly operated by the Modesto Irrigation District (MID) and the Turlock Irrigation District (TID).

The portion of the Tuolumne River that falls in the valley floor subwatershed flows through the agricultural area downstream of New Don Pedro Reservoir. This portion of the river extends from the San Joaquin River upstream to La Grange, which is approximately 5 miles downstream of New Don Pedro Reservoir. Key diversions, inflows, and river flows affecting this part of the river are shown in Table 3-69. This table presents minimum, mean, and maximum of the monthly average flows recorded between 1995 and 2004.

Downstream of New Don Pedro Reservoir, near La Grange, water is diverted by both MID and TID (Table 3-69). From June through October, usually more than half of the river flow is diverted.

Dry Creek is a moderate-size tributary to the lower section of the Tuolumne River. It enters the river at the city of Modesto approximately 0.2 mile upstream of the USGS Tuolumne River flow gage at Modesto. Dry Creek drains an area of about 190 square miles (City of Modesto 2003a). While the flows in Dry Creek are not large (Table 3-69), they can carry runoff from agricultural lands, dairies, and storm season runoff from the city of Modesto (2005 ESJ coalition report). Flows from Dry Creek generally contribute less than half of the flow gains in the Tuolumne River between La Grange and Modesto.

Table 3-69. Tuolumne River Flows (cfs) Measured from 1995 through 2004

	Modesto Canal Diversion[a]			Turlock Canal Diversion[a]			Tuolumne River below La Grange[a]			Dry Creek Inflow[b]			Tuolumne River at Modesto[a]		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	6	83	237	0	181	544	176	1,932	13,074	18	114	441	298	2,393	15,498
Feb	44	83	168	0	274	599	171	3,193	8,116	4	276	974	262	3,620	8,782
Mar	121	292	642	454	764	1,457	165	2,733	5,407	9	80	179	299	3,103	5,665
Apr	250	541	720	699	1,111	1,304	558	2,298	6,920	28	56	156	718	2,507	7,163
May	310	640	872	800	1,227	1,710	412	2,117	7,935	35	56	80	582	2,273	7,862
Jun	655	785	954	1,243	1,539	1,725	54	1,136	4,918	48	100	400	240	1,334	5,481
Jul	781	892	1,041	1,805	1,893	2,081	88	764	3,104	57	71	93	238	924	3,291
Aug	703	807	927	1,489	1,607	1,796	86	409	1,107	69	85	105	241	612	1,437
Sep	461	555	719	617	824	1,063	68	537	2,067	44	77	103	227	753	2,365
Oct	268	382	609	358	573	883	189	474	1,460	16	41	110	334	703	1,794
Nov	0	88	195	0	16	59	184	288	392	4	9	20	248	403	520
Dec	0	50	86	0	89	301	177	800	4,625	1	29	141	299	941	4,996

[a] Data obtained from USGS website. No data for Turlock Canal for October 1, 2004–December 31, 2004. Measurements at Modesto are taken 0.2 miles downstream of Dry Creek.

[b] Data obtained from CDEC website. No measurements until April 1997.

Merced River

The Merced River drains approximately a 1,276–square mile watershed just south of the Tuolumne River. Exchequer Dam forms Lake McClure, the largest reservoir on the Merced River, with a capacity of 1,046,000 acre-feet and a watershed of approximately 1,037 square miles. Downstream of Lake McClure, McSwain Dam forms Lake McSwain.

Downstream of Lake McSwain, Merced Falls Dam impounds water for diversion into the North Side Canal for delivery to agricultural land. The largest water diversion occurs above Crocker-Huffman Dam, where water enters the Merced Irrigation District’s Main Canal. This diversion accounts for the majority of the flow reduction between the Merced River below Merced Falls and the Merced River at Cressy (Table 3-70).

The portion of the Merced River that falls in the SJVFS watershed extends from the San Joaquin River upstream to the Merced Falls Dam. This portion of the Merced River is dominated by agricultural land use.

Small amounts of water are returned to the river downstream of Crocker-Huffman Dam at the North Side Canal spill, Livingston Canal spill, and Highline Canal spill. Of these three agricultural return flows, the Highline Canal may be the most contaminated. Agricultural return flows are part of the reason that flows in the Merced River near Stevinson are greater than the flows in the Merced River near Cressy, approximately 23 miles upstream (Table 3-70).

Dry Creek flows into the Merced River near Snelling. Dry Creek typically lives up to its name by drying up during the summer upstream of the confluence with the Merced River, although it may provide groundwater infiltration into the Merced River. Table 3-70 contains minimum, mean, and maximum flows at Dry Creek near Snelling from 2000 to 2004.

Table 3-70. Merced River Flows (cfs) Measured from 1995 through 2004

	Merced River below Merced Falls[a]			Dry Creek near Snelling[b]			Merced River at Cressy[c]			Merced River near Stevinson[d]		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	201	1,064	7,368	8	48	209	194	269	346	233	434	762
Feb	214	1,763	6,686	0	108	336	208	573	1,784	217	1,182	4,878
Mar	443	1,554	3,043	5	47	160	206	649	2,196	235	1,161	2,742
Apr	1,087	1,936	3,904	0	14	66	324	666	1,171	364	1,272	3,291
May	1,688	2,423	4,781	0	4	14	497	679	886	403	1,240	3,755
Jun	1,650	2,314	4,847	0	1	9	164	197	242	117	798	3,232
Jul	1,746	2,343	4,804	0	0	3	110	120	143	83	582	2,497
Aug	1,343	1,682	2,484	0	0	0	76	94	118	74	217	568
Sep	748	1,244	2,424	0	1	4	84	147	348	65	292	970
Oct	711	1,255	2,601	0	2	8	277	349	578	175	486	1,111
Nov	236	363	551	0	3	13	226	305	478	215	345	580
Dec	209	543	2,180	2	38	182	211	294	435	223	311	471

[a] Data from USGS website. Missing October 2004–December 2004.
[b] Data from CDEC website. Missing January 1995–April 1997.
[c] Data from CDEC website. Missing January 1995–March 1999.
[d] Data from CDEC website. Missing November 1995–April 1997.

Bear Creek

Bear Creek originates much lower in the Sierra Nevada Mountains than the Stanislaus, Tuolumne, and Merced Rivers. It starts in Mariposa County near the town of Bear Valley, which is at 2,050 feet elevation. Just before entering Merced County, Bear Creek flows through Bear Reservoir, a small reservoir operated by the U.S. Army Corps of Engineers (Corps).

In Merced County, Bear Creek flows through the city of Merced before passing by duck club property and entering the Eastside Bypass, which joins the San Joaquin River near the Great Valley Grasslands State Park. The portion of Bear Creek that flows through the valley floor watershed extends from the Eastside Bypass to Bear Reservoir.

The USGS does not have any active gages on Bear Creek. However, CDEC does have two stations along Bear Creek—one at Bear Reservoir and one near McKee Road near Merced. Flows from these gages are presented in Table 3-71.

Flows in Bear Creek are low, especially from April through November. During this time, very little water is released from Bear Reservoir. By the time the creek reaches McKee Road, however, there has been a relatively large increase in flow, an average of roughly 100 cfs. Some of this additional water may come from Rascal Creek, Fahrens Creek, Fairfield Canal, and Le Grand Canal.

Table 3-71. Bear Creek Flows (cfs) Measured from 1995 through 2004

	Bear Reservoir Release			Bear Creek near McKee Road		
	Min	Mean	Max	Min	Mean	Max
Jan	0	125	428	1	240	1,035
Feb	0	116	473	11	357	1,306
Mar	0	80	370	9	158	457
Apr	0	32	135	24	87	137
May	0	12	35	20	143	255
Jun	0	5	18	27	181	306
Jul	0	3	12	39	181	267
Aug	0	2	12	33	144	215
Sep	0	2	10	10	65	128
Oct	0	3	13	6	50	120
Nov	0	5	15	0	34	114
Dec	0	22	59	0	68	208

Source: CDEC website. No data from McKee Road gage for 1995 and 1996.

Chowchilla River

Eastman Lake, formed by Buchanan Dam, is the only large reservoir in the Chowchilla River watershed. It has a capacity of 150,000 acre-feet, and its watershed area is 235 square miles. The only currently operated measurement station along the Chowchilla River is the CDEC station at Eastman Lake. Releases from the lake are shown in Table 3-72. Releases from the lake are typically less than 200 cfs.

For the SJVFS, the area of interest starts approximately 6 miles downstream of Eastman Lake at the intersection of Merced, Mariposa, and Madera Counties. Much of the lower portion of the river forms the boundary between Merced and Madera Counties.

The lower Chowchilla River is north of the town of Chowchilla. Upstream of the town of Chowchilla, water is diverted south from the Chowchilla River to supply Barenda and Ash Sloughs (Vollmar 2005). Downstream of the town of Chowchilla (to the west) the Chowchilla River enters the East Side Bypass, which eventually flows into the San Joaquin River.

Table 3-72. Chowchilla River Flows Downstream of Eastman Lake Measured from 1995 through 2004

	Eastman Lake Release (cfs)		
	Min	Mean	Max
Jan	0	188	1,852
Feb	0	188	1,107
Mar	0	131	334
Apr	0	77	525
May	0	43	183
Jun	26	163	323
Jul	114	214	340
Aug	7	173	503
Sep	0	66	168
Oct	0	819	7,459
Nov	0	10	104
Dec	0	67	633

Source: CDEC website.

Fresno River

Mostly dominated by rainfall, the Fresno River watershed is 500 square miles located at a relatively low elevation in Madera County. Hensley Lake, formed by Hidden Dam, is the only large reservoir in the Fresno River watershed. It is operated by the Corps and has a capacity of 90,000 acre-feet. The watershed area of the lake is approximately 237 square miles (Bookman-Edmonston 2003). The Madera Irrigation District obtains some of its water from the Fresno River.

Historically, Fresno River has had ephemeral flows consisting of large winter floods and no summer flows (Bookman-Edmonston 2003). The only currently operated measurement station along the Fresno River is the CDEC station at Hensley Lake. Releases from the lake are shown in Table 3-73. Releases from the lake are typically less than 200 cfs.

Table 3-73. Fresno River Flows downstream of Hensley Lake Measured from 1995 through 2004

	Hensley Lake Release (cfs)		
	Min	Mean	Max
Jan	0	158	1,487
Feb	0	238	1,020
Mar	0	162	823
Apr	0	77	331
May	0	109	193
Jun	41	167	287
Jul	118	193	272
Aug	73	144	221
Sep	0	64	145
Oct	0	73	291
Nov	0	23	169
Dec	0	95	746

Source: CDEC website.

The portion of the Fresno River that lies in the SJVFS starts a few miles downstream of Hensley Lake and extends to the Chowchilla Bypass, which eventually drains into the San Joaquin River. However, water from the Fresno River seldom reaches the Chowchilla Bypass.

Harding Drain and Other Small Tributaries

Within the SJVFS area, multiple small drainages flow directly into the San Joaquin River. Several of these have been identified as having water quality concerns, including Harding Drain and August Road Drain at Crows Landing. Both of these drains are located between the Merced and Tuolumne Rivers, with Harding Drain being north of the August Road Drain. Harding Drain, also known as TID Lateral Number 5, conveys agricultural runoff and discharge from the City of Turlock's wastewater treatment plant (TID 2005).

Dutchman Creek and Duck Slough are two other small waterways with water quality issues. Dutchman Creek and Duck Slough are located between Bear Creek and the Chowchilla River. Dutchman Creek flows into Deadman Creek, which joins with Duck Slough at its downstream end.

San Joaquin River

The San Joaquin River between Friant Dam and the Delta forms the western and southern boundaries of the SJVFS and is described here. This description extends to the San Joaquin River at Vernalis, which is the sampling location upstream of any tidal influence from the Delta. Vernalis is only about 2 miles north of the SJVFS boundary and it should be included with the valley floor description because Vernalis is a key water quality measurement location that represents the cumulative water quality conditions resulting from all the upstream inflows.

The San Joaquin River is the major surface water feature in the SJVFS. The total San Joaquin River basin drains 7,395 square miles, 4,320 square miles of which are in the Sierra Nevada Mountains, and 2,273 are in the San Joaquin Valley (USGS 2002b). Millerton Lake, formed by Friant Dam, is the main reservoir on the San Joaquin River. It has a capacity of 520,000 acre-feet and is located at river mile (RM) 267.5, just outside of the southeastern corner of the valley floor watershed. Completed in 1949, Friant Dam is owned and operated by Reclamation as part of the CVP. The USGS National Water Quality Assessment Program is a huge contributor to data for the San Joaquin River. Most of the flow and water quality data for this section was obtained from this program.

Most of the runoff stored in Millerton Lake is diverted and not conveyed down the San Joaquin River. As a result, except under floodflow conditions, the river is dry between Gravelly Ford (RM 229) and Mendota Pool (RM 206) in most years. Water imported via the DMC provides flows between Mendota Dam (RM 204.6) and Sack Dam (RM 182.1), but the river is again dewatered as far as the Sand Slough Control Structure (RM 168.5) in most years. Agricultural tailwater provides some flow downstream of the Sand Slough Control Structure.

Flows remain low until the river goes past the city of Stevinson and reaches Salt Slough and Mud Slough, which have fairly reliable flows during the summer months attributable to agriculture return flows. Just downstream of Salt Slough and Mud Slough the flow is greatly increased at the confluence with the Merced River. According to USGS flow records of 1951 to 1995, 66% of the average flow at the downstream end of the San Joaquin River comes from three major east-side river basins: the Merced River (15%), the Tuolumne River (30%), and the Stanislaus River (21%) (USGS 2002b).

The variability in flows along the length of the San Joaquin River can be seen in Table 3-74. All of these measurements are in areas of consistent flow. Releases from Friant Dam are generally greater than 100 cfs. The flows measured near Mendota are between Mendota Pool and Sack Dam and are sustained by DMC flows into Mendota Pool. The Fremont Ford Bridge flows are sustained by flows from Salt Slough. Crows Landing is downstream of Mud Slough, the Merced River, and Orestimba Creek, so flows are considerably higher. They are highest at Vernalis, which is downstream of all major inflows.

Table 3-74. San Joaquin River Flows (cfs) Measured from 1995 through 2004

	San Joaquin River below Friant Dam[a]			San Joaquin River near Mendota[b]			San Joaquin River at Fremont Ford Bridge[c]			San Joaquin River near Crows Landing[d]			San Joaquin River near Vernalis[e]		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	73	1,021	9,144	14	95	144	263	5,538	25,603	888	3,930	25,603	1,792	5,911	30,377
Feb	95	1,195	6,514	185	288	341	233	5,730	23,389	804	6,219	23,389	1,879	10,954	35,057
Mar	86	1,099	4,203	209	248	329	329	2,404	6,034	870	3,547	10,134	2,134	9,362	19,352
Apr	97	1,297	6,074	179	222	259	182	787	1,991	706	2,735	13,983	2,598	7,657	21,937
May	131	1,460	7,637	257	305	359	149	898	2,800	937	2,564	12,094	2,625	7,524	22,187
Jun	189	1,162	6,535	496	528	556	144	441	1,132	454	1,895	11,887	1,404	5,034	17,760
Jul	201	1,185	5,322	546	579	601	158	373	800	403	1,401	8,176	1,147	3,613	13,193
Aug	191	274	464	397	405	421	145	376	812	408	692	1,757	1,116	2,227	5,442
Sep	181	237	383	183	227	292	83	316	797	326	640	1,842	1,121	2,407	5,758
Oct	133	195	357	103	185	247	103	723	2,338	631	1,115	2,338	1,705	3,145	6,153
Nov	87	158	378	66	148	186	165	553	1,027	731	955	1,228	1,647	2,284	3,290
Dec	82	278	1,147	1	73	158	145	1,153	4,364	687	1,338	4,364	1,503	3,374	12,192

[a] data from Jan 1995–Sep 2004.
[b] data from Dec 1999–Sep 2004.
[c] data from Oct 2001–Sep 2004.
[d] data from Oct 1995–Sep 2004.
[e] data from Jan 1995–Sep 2004.
Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR land use data were used for the purposes of this report because they were the only land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Land use in the valley floor watershed is primarily agricultural (Table 3-75), although at the higher elevations there is significant native vegetation (Figure 3-35).

Table 3-75. Land Use Acreage according to DWR and FRAP Land Use Data for the San Joaquin Valley Floor Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	7,769	0.4
Deciduous Fruits and Nuts	371,893	20.7
Field Crops	225,157	12.6
Grain and Hay	57,454	3.2
Idle	14,019	0.8
Pasture	222,894	12.4
Rice	9,697	0.5
Semiagricultural and Incidental	35,605	2.0
Truck, Nursery, and Berry Crops	41,189	2.3
Vineyards	140,922	7.9
Subtotal	1,126,599	62.8
Urban		
Urban—unclassified	76,018	4.2
Urban Landscape	6,027	0.3
Urban Residential	22,313	1.2
Industrial	8,947	0.5
Commercial	2,424	0.1
Vacant	18,779	1.0
Subtotal	134,508	7.3
Native		
Native Vegetation	513,722	28.7
Barren and Wasteland	32	0.002
Riparian Vegetation	2,499	0.1

DWR Land Use Type	Acres	Percent Total
Water Surface	15,018	0.8
Subtotal	531,271	29.6
Not Surveyed	7	0.0004
FRAP Land Use Type		
Pasture	0.14	0.00001
Native Vegetation	0.03	0.000002
Subtotal	0.17	0.0
Total	**1,792,389**	**100**

Urban land use represents only a small portion of land use in the subwatershed. DWR land use types of commercial, industrial, residential, urban, and urban landscape combine for a total of 115,730 acres, or about 6.5% of the total acres in the watershed. The most substantial land use is by far agriculture. It represents approximately 62% of the acres in the watershed (1,112,581 acres). Almost all of the agricultural land is irrigated, although pastureland and certain crops such as wheat and safflower may not require irrigation. In addition, pasture may or may not be irrigated. Native vegetation, which is predominantly in the eastern portion of the watershed, occupies about 29% of the subwatershed (516,221 acres). The remaining acres are barren, idle, vacant, not surveyed, or water and together represent 2.7% of the total watershed acreages. See Table 3-76 for all of the exact acreages by land use type.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the San Joaquin Valley Floor Subwatershed. Table 3-76 lists the beneficial uses of the lower Stanislaus River (Goodwin Dam to San Joaquin River), Tuolumne River (New Don Pedro Dam to San Joaquin River), Merced River (McSwain Reservoir to San Joaquin River), Chowchilla River (Buchanan Dam to San Joaquin River), and Fresno River (Hidden Dam to the San Joaquin River). The table also includes beneficial uses for four sections of the San Joaquin River. The Basin Plan does not list beneficial uses for Bear Creek. It also does not list irrigation as a beneficial use for the Merced River downstream of McSwain Reservoir even though there are some large agricultural diversions downstream of McSwain Dam.

Table 3-76. Beneficial Uses by River in the San Joaquin Valley Floor Subwatershed

Beneficial Uses	Stanislaus River	Tuolumne River	Merced River	Yosemite Lake	Chowchilla River	Fresno River	San Joaquin River, Friant Dam to Mendota Pool	San Joaquin River, Mendota Dam to Sack Dam	San Joaquin River, Sack Dam to Merced River	San Joaquin River, Merced River to Vernalis
Municipal and Domestic	P	P	P		P	P	E	P	P	P
Irrigation	E	E			E	E	E	E	E	E
Stock Watering	E	E	E			E	E	E	E	E
Process	E		E		E		E	E	E	E
Service Supply	E		E							
Hydropower	E		E							
Rec-1	E	E	E	E	E	E	E	E	E	E
Rec-2	E	E	E	E	E	E	E	E	E	E
Freshwater Habitat—Warm	E	E	E	E	E	E	E	E	E	E
Freshwater Habitat—Cold	E	E	E	E			E			
Migration—Warm			E				E	E	E	E
Migration—Cold	E	E	E				E	E	E	E
Spawning—Warm	E	E	E				E	E	E	E
Spawning—Cold	E	E	E				P	P	P	
Wildlife Habitat	E	E	E	E	E	E	E	E	E	E
Navigation										

P = Potential, E = Existing.
Process is industrial use that depends on water quality.
Service supply is industrial use that is not dependent on water quality.
Rec-1 is contact and canoeing or rafting and Rec-2 noncontact.
Source: Data obtained from the Sacramento San Joaquin River Basin Plan.

Impaired Status

The CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. Within the SJVFS, the lower Stanislaus, Tuolumne, and Merced Rivers and Harding Drain are listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003.

According to the CWA Section 303(d) list of water quality–impaired rivers, the lower Stanislaus River (59 miles) is impaired for diazinon, group A pesticides, mercury, and unknown toxicity. The Tuolumne River downstream of New Don Pedro Reservoir (60 miles) is listed as impaired for diazinon, group A pesticides, and unknown toxicity. The Merced River from McSwain Reservoir to the San Joaquin River (50 miles) is listed as impaired for chlorpyrifos, diazinon, and group A pesticides. Harding Drain is listed as impaired for ammonia, chlorpyrifos, diazinon, and unknown toxicity.

The impairments for the San Joaquin River between Mendota Pool and Vernalis are divided into four reaches. All of these reaches are listed as impaired for boron, chlorpyrifos, DDT, diazinon, EC, group A pesticides, and unknown toxicity. The three reaches between Bear Creek and Vernalis are also listed as impaired for mercury. The section of the San Joaquin River that extends from Mud Slough to the Merced River has one additional water quality constituent on its list of impairments—selenium. Mendota Pool, which is part of the San Joaquin River upstream of Salt Slough and Sack Dam, is also listed as impaired for selenium. Although the rest of the San Joaquin River is not on the 303(d) list as impaired for selenium, Basin Plan goals have been established for the San Joaquin River downstream of the Merced River (Central Valley Water Board 2001b).

Agriculture is listed as the potential source for the elevated levels of boron, DDT, EC, chlorpyrifos, diazinon, ammonia, and group A pesticides; resource extraction (mining) is listed as the potential source for the elevated levels of mercury. The ammonia in Harding Drain could also come from municipal point sources. Table 3-77 contains the TMDL priority status for each impairment.

Table 3-77. Impaired Designations by River Sub-Areas

Watershed/Subwatershed	Pollutant	TMDL Priority	Approximate Size Affected
Stanislaus River	Diazinon	Medium	59 miles
	Group A Pesticides	Low	
	Mercury	Low	
	Unknown Toxicity	Low	
Tuolumne River	Diazinon	Medium	60 miles
	Group A Pesticides	Low	
	Unknown Toxicity	Low	
Harding Drain	Ammonia	Low	8.3 miles
	Chlorpyrifos		
	Diazinon		
	Unknown Toxicity		
Merced River	Chlorpyrifos	Medium	50 miles
	Diazinon	Medium	
	Group A Pesticides	Low	
A. San Joaquin River (Mendota Pool to Bear Creek)	Boron	High	67 miles
	Chlorpyrifos	High	
	DDT	Low	
	Diazinon	High	
	EC	High	
	Group A Pesticides	Low	
	Unknown Toxicity	Low	
B. San Joaquin River (Bear Creek to Mud Slough)	Same as (A) Plus: Mercury	Medium	14 miles
C. San Joaquin River (Mud Slough to Merced River)	Same as (B) Plus: Selenium	Low	3 miles
San Joaquin River (Merced River to South Delta Boundary)	Same as (B)		43 miles
Mendota Pool	Selenium	Low	3,045 acres

Data obtained from CWA Section 303(d)

Table 3-78 presents some of the federal and state criteria for water quality constituents that are included in the CWA Section 303(d) listed waterways in the SJVFS. Dieldrin is chosen to represent the group A pesticides because it is the only one that is measured in the water column as opposed to the remaining group A pesticides, which are measured in sediment. Mercury criteria are either for total or for inorganic mercury. The ammonia criteria for the protection of freshwater aquatic life depend on pH, temperature, and whether juvenile fish are present. The ammonia criteria values range from 179 to 10,800 µg/L (Central Valley Water Board web site 2005).

Table 3-78. Water Quality Criteria

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)		
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL	CDHS Action Level	CTR
Diazinon	0.05	0.08	0.10	0.10	0.600	6.000	NA
Chlorpyrifos	0.014	0.02	0.041	0.083	20.00	NA	NA
Dieldrin (Group A Pesticides)	NA	NA	0.056	0.24	0.5	0.002	0.00014
Mercury	NA	NA	0.77 (total)	1.4 (total)	2.0 (inorganic)	NA	0.05 (total)
Boron	NA	NA	NA	NA	600	1,000	NA
DDT	NA	NA	.001	NA	NA	NA	0.00059
Selenium	NA	NA	5	NA	50	NA	NA

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. CTR values are the 30-day average values for drinking water for the California Toxics Rule.

Sources: EPA 2003, 2004; Siepman and Finlayson 2000; Federal Register; Central Valley Water Board 2005. The EPA has established a tissue residue criterion of 0.3 mg methylmercury/kg fish (EPA 2001).

The Basin Plan also has water quality criteria for some of the 303(d) constituents of concern for the SJVFS. They are as follows:

- **Boron**—Criteria for Boron in the San Joaquin River between the Merced River and Vernalis range between 800 and 2,600 µg/L, depending on time of year and year type. Also, maximum and monthly mean concentrations have different criteria. The EPA SNARL of 600 µg/L is more restrictive than any of the Basin Plan values.
- **Selenium**—Basin Plan criteria for selenium in the San Joaquin River from the Merced River to Vernalis are 12 µg/L for a maximum value and 5 µg/L for a 4-day average. For the San Joaquin River from Sack Dam to the Merced River, these criteria are 20 µg/L for a maximum value and 5 µg/L for a 4-day average.
- **EC**—The Basin Plan has an EC criterion of 150 µmhos/cm for the area between Friant Dam and Gravelly Ford, a section of river that is not considered to be impaired in the 303(d) list. The Basin Plan also has criteria for the 30-day running average EC in the San Joaquin River at Vernalis of 700 µmhos/cm for April 1–August 31 and 1,000 µmhos/cm for September 1–March 31.
- **Molybdenum**—The Basin Plan has criteria for molybdenum levels in the San Joaquin River, although the San Joaquin River is not listed as impaired for molybdenum.

Since the creation of the Basin Plan, the process of establishing TMDLs has been initiated for several water quality constituents. In some cases, a TMDL resultes in an amendment to the Basin Plan. For the lower San Joaquin River, there is a draft amendment to the Basin Plan for the control of diazinon and chlorpyrifos (Central Valley Water Board 2005b) and a final amendment to the Basin Plan for the control of salt and boron (Central Valley Water Board 2004). The draft amendment for diazinon and chlorpyrifos proposes new acute toxicity targets of 0.16 µg/L for diazinon and 0.025 µg/L for chlorpyrifos. The amendment for salt and boron includes new EC criteria for nonpoint source discharges to the lower San Joaquin River. It is expected that, if the salt load is reduced as required, both the EC and boron goals of the Basin Plan will be met. The Central Valley Water Board has adopted a TMDL for a Salt and Boron to be a part of the Basin Plan. The TMDL is currently under review at the State Board, Office of Administrative Law.

Water Quality

Diazinon and chlorpyrifos have been of particular concern in the SJVFS. These organophosphorus pesticides are typically applied during the winter dormant season, with chlorpyrifos use extending into the spring. Wintertime surveys of these insecticides indicate that some of the higher concentrations occur in some of the smaller tributaries (USGS 2002b) and that concentrations in precipitation were very high (USGS 2003). River concentrations of these chemicals tend to be highest during the beginning part of a storm event, which is also referred to as the “first flush” storm event (USGS 2003).

The Central Valley Water Board has adopted the San Joaquin River TMDL for the control of diazinon and chlorpyrifos and was adopted in November of 2005. The Central Valley Water Board has written a draft amendment to the Basin Plan for the control of diazinon and chlorpyrifos runoff into the lower San Joaquin River (Central Valley Water Board 2005b). Diazinon and chlorpyrifos concentrations measured from 1991 through 2005 were compiled for the draft amendment and adopted as water quality objectives of 0.16 µg/L for diazinon and 0.025 µg/L for chlorpyrifos were developed. These values are higher than the DFG acute criteria of 0.08 µg/L for diazinon and 0.02 µg/L for chlorpyrifos (Table 3-78).

During the past 10 years, the use of diazinon and chlorpyrifos in the SJVFS has decreased substantially (USGS 2002b). The concentration of these pesticides in the rivers has also decreased (Central Valley Water Board 2005b). In recent years, pyrethroids have been replacing some organophosphate use. Pyrethroids tend to bind with organic material and may be more likely to be present in sediment than water (ESJWQC 2004).

In 2004, the ESJWQC and several irrigation districts initiated water quality monitoring within the SJVFS. The constituents evaluated varied. The pesticides selected for evaluation were dependent on which pesticides were used by the irrigation district or the coalition members. Most of the monitoring sites were located on relatively small creeks, drains, and spills. These sites are expected to have more water quality problems because they contain more concentrated agricultural runoff. Some of these sites are not monitored by other organizations, so these data will be a valuable source of information, particularly after more data can be collected. Even though water quality constituents in these small discharges might not always meet water quality objectives, beneficial uses in the receiving water may be maintained because the discharges often become significantly diluted.

As part of the evaluation of water quality data, the USGS water quality database (USGS website 2005) was searched for data on the parameters and locations of concern from the 303(d) list. Data collection sites chosen for evaluation were those that had significant amounts of data. For the tributaries to the San Joaquin River, the best sites were located as low as possible in the watershed. Most evaluation was limited to data collected from 1995 through 2004. However, if no data were available for this period, older data were included. As part of this evaluation, the percent of measurements exceeding a threshold was calculated. The thresholds were generally the lowest criteria present on Table 3-78. Because the criteria selected may not be applicable to a particular water body, the purpose of this calculation is only to produce a general indicator of elevated concentrations, not to detect water quality violations. For example, a particular river may not be a source of drinking water, but exceedances of a drinking water criterion are indicative of potential problems in that watershed or downstream. For ammonia and EC, the water quality criteria are variable, and the thresholds selected for the evaluation of data were 10 mg/L for ammonia and 700 µmhos/cm for EC.

Stanislaus River

As discussed above, the Stanislaus River is impaired for diazinon, group A pesticides, mercury, and unknown toxicity. Table 3-79 shows data available from the USGS (USGS website 2005) for these constituents for the Stanislaus River at Caswell State Park near Ripon. Data for dieldrin are not shown because dieldrin was not detected, and the detection limit was greater than the lowest water quality criteria, 0.00014 µg/L.

Samples for analysis of mercury were collected from the Stanislaus River at Ripon during 1985–1988. The usefulness of the data from these samples is limited because the detection limit (0.1 µg/L) was greater than the CTR criteria of 0.05 µg/L. Only two of the 47 mercury samples had detectable levels of mercury (both were just equal to the detection limit of 0.1 µg/L).

Table 3-79. Diazinon Concentrations in the Stanislaus River at Caswell State Park near Ripon

	Diazinon
Earliest date	Jan-00
Latest date	Aug-01
Count	63
Average (µg/L)	0.020
Minimum (µg/L)	0.001
Maximum (µg/L)	0.083
Percent Exceedances	14

A criterion of 0.05 µg/L was used for the percent exceedance calculation

As tabulated by the Central Valley Water Board, of 155 samples collected for Diazinon analysis in the Stanislaus River at Caswell State Park since 2000, only about 3% have had diazinon concentrations greater than the acute toxicity target of 0.16 µg/L proposed in the draft modification to the Basin Plan (Central Valley Water Board 2005b). Most of the exceedances occurred during 2005.

Although the Stanislaus River is not listed as impaired for chlorpyrifos, elevated levels of this chemical have been detected. As tabulated by the Central Valley Water Board, of 158 measurements taken in the Stanislaus River at Caswell State Park since 2000, about 3% have had chlorpyrifos concentrations greater than the acute toxicity target of 0.025 µg/L proposed in the draft modification to the Basin Plan (Central Valley Water Board 2005b).

All mercury impairments are based on the belief that there are elevated fish tissue levels. The decision to list the Stanislaus River for mercury impairment was based on a study that found an average mercury concentration of 0.53 mg/L in trophic level 4 fish obtained from the lower portion of the river. Levels are presumed to be similar farther upstream because the source of the mercury probably comes from historical gold mining that took place in the upper watershed (Central Valley Water Board 2001).

Tuolumne River

As discussed above, the lower Tuolumne River is listed as impaired for diazinon, group A pesticides, and unknown toxicity. Table 3-80 shows data available from the USGS (USGS website 2005) for these constituents for the Tuolumne River at Shiloh Road. Dieldrin concentrations were assessed but never detected. The dieldrin detection limits (0.001 µg/L and occasionally 0.005 µg/L) were relatively high compared to the criteria.

Table 3-80. Diazinon Concentrations in the Tuolumne River at Shiloh Road

	Diazinon
Earliest date	Jan-00
Latest date	Aug-01
Count	68
Average (µg/L)	0.022
Minimum (µg/L)	0.002
Maximum (µg/L)	0.201
Percent Exceedances	10

A criterion of 0.05 µg/L was used for the percent exceedance calculation.

As tabulated by the Central Valley Water Board, of 174 samples collected for diazinon analysis from the Tuolumne River at Shiloh Road since 2000, only about 2% of the measurements had diazinon concentrations greater than the acute toxicity target of 0.16 µg/L proposed in the draft modification to the Basin Plan (Central Valley Water Board 2005b). Most of the exceedances occurred during 2005.

Although the Tuolumne River is not listed as impaired for chlorpyrifos, elevated levels of this chemical have been detected. As tabulated by the Central Valley Water Board, of 168 samples collected for chlorpyrifos analysis from the Tuolumne River at Shiloh Road since 2000, about 3% of the results showed chlorpyrifos concentrations greater than the acute toxicity target of 0.025 µg/L proposed in the draft modification to the Basin Plan (Central Valley Water Board 2005b).

Chlorpyrifos and diazinon levels have also been measured in the Dry Creek, a tributary that enters the Tuolumne River near the city of Modesto (USGS 2002b, 2003). For both pesticides, concentrations were higher in Dry Creek than in the Tuolumne River at Shiloh Road (downstream of Dry Creek). This is likely because Dry Creek contains higher concentrations of agriculture return flows in addition to the city of Modesto runoff.

During the 2004 irrigation season and the 2004–2005 storm season, the MID sampled 7 sites in the Tuolumne River watershed for water quality constituents that included six pesticides (but not diazinon or chlorpyrifos). Almost no pesticides were detected during the irrigation season, but during the storm season, elevated levels of the herbicides diuron and oryzalin were detected in the Waterford Lower Main Canal (MID 2005).

Harding Drain and Other Small Tributaries

As discussed above, Harding Drain is impaired for ammonia, diazinon, chlorpyrifos, and unknown toxicity. Table 3-81 presents the data available from the USGS website database for these constituents for the Harding Drain at Carpenter Road.

Table 3-81. Chlorpyrifos, Diazinon, and Ammonia Concentrations in Harding Drain at Carpenter Road

	Chlorpyrifos	Diazinon	Ammonia
Earliest date	Sep-99	Sep-99	Sep-99
Latest date	Aug-01	Aug-01	Oct-01
Count	12	12	9
Average (µg/L)	0.008	0.039	2.027
Minimum (µg/L)	0.005	0.012	0.330
Maximum (µg/L)	0.013	0.069	4.710
Percent Exceedances	0	33	11

Exceedance criteria were 0.014 µg/L for chlorpyrifos, 0.05µg/L for diazinon, and 10 mg/L for ammonia

As summarized in the amendment to the Basin Plan (Central Valley Water Board 2005b), during 1991–1994, elevated levels of chlorpyrifos and diazinon were detected in Harding Drain. In general, concentrations of these chemicals have decreased within the waterways of the San Joaquin River basin. Since 2000, less than 15 measurements have been made for these chemicals in Harding Drain. None of these recent measurements exceeded the acute toxicity targets proposed by the Central Valley Water Board (0.16 µg/L for diazinon and 0.025 µg/L for chlorpyrifos). These recent measurements are in agreement with the USGS data because none of the recent diazinon values in the USGS data set exceeded 0.16 µg/L.

During 2004, the ESJWQC monitored water quality in Dutchman Creek at Gurr Road, Duck Slough at Gurr Road, and August Road Drain at Crows Landing. This monitoring included evaluation of basic water quality parameters (e.g., temperature, dissolved oxygen, and pH), sampling for six pesticides (including diazinon and chlorpyrifos), and measurement of sediment and water column toxicity. During the 2004 monitoring, water quality objectives for *E. coli*, total TDS, and water column and sediment toxicity were exceeded at the Duck Slough site. At the Dutchman's Creek site, water quality objectives for *E. coli* were exceeded and, at August Drain, water quality objectives for *E. coli*, TDS, and EC were exceeded (Johnson and Klassen 2005).

During the 2004 irrigation season and the 2004–2005 rainy season, TID monitored several small waterways in the land between the lower Tuolumne and lower Merced Rivers. During the storm season, elevated levels of the pesticide diuron were found in Lower Lateral 2 1/2, which spills to the San Joaquin River (TID 2005).

The Merced Irrigation District monitored water quality at eight sites within its operational area during the 2004 irrigation season and the 2004–2005 storm season. Elevated levels of iron, higher than the water quality objective for agricultural water, were detected in two potential tributaries to the San Joaquin River—Owens Creek and Benedict Lateral, which spill to Deadman Creek. Both of these drainages are between Bear Creek and the Chowchilla River (MID 2005).

Merced River

As discussed above, the Merced River is listed as impaired for chlorpyrifos, diazinon, and group A pesticides. Table 3-82 provides a summary of recent data collected by the USGS in the Merced River at River Road for these water quality constituents. Dieldrin concentrations were assessed but never detected. The dieldrin detection limits (0.001 µg/L and occasionally 0.005 µg/L) were relatively high compared to the criteria.

Table 3-82. USGS Data for Chlorpyrifos and Diazinon in the Merced River at River Road

	Chlorpyrifos	Diazinon
Earliest date	Feb-97	Feb-97
Latest date	Aug-04	Aug-04
Count	177	177
Average (µg/L)	0.006	0.014
Minimum (µg/L)	0.002	0.002
Maximum (µg/L)	0.025	0.435
Percent Exceedances	4	3

Exceedance criteria were 0.014 µg/L for chlorpyrifos, 0.05 µg/L for diazinon, and 10 mg/L for ammonia

As tabulated by the Central Valley Water Board, of 154 samples collected for diazinon analysis from in the Merced River at River Road since 2000, only about 2% of the results had diazinon concentrations greater than the acute toxicity target of 0.16 µg/L proposed in the draft modification to the Basin Plan (Central Valley Water Board 2005b). The percent exceedance presented in the draft modification to the Basin Plan is slightly different from the percent exceedance presented in Table 3-82 because different data sets and different criteria were used.

For chlorpyrifos, the Central Valley Water Board reported that approximately 3% of 154 samples collected for chlorpyrifos analysis from the Merced River at River Road since 2000 had chlorpyrifos concentrations greater than the acute toxicity target of 0.025 µg/L (Central Valley Water Board 2005b). Most of the exceedances occurred during 2005.

During January and February 2000, samples for chlorpyrifos and diazinon analysis were collected from the Merced River, the Highline Canal, and the Livingston Canal (USGS 2002b). The chronic chlorpyrifos criterion of

0.014 µg/L was not exceeded. The chronic diazinon criterion of 0.05 µg/L was exceeded in Livingston Canal and Highline Canal on multiple occasions, but it was not exceeded in the Merced River at River Road. Highline and Livingston Canals drain into the Merced River upstream of the River Road location, and consist primarily of agriculture return flows.

During 2004, the ESJWQC monitored water quality in the Merced River at Santa Fe Drive. Water column toxicity of unknown origin was detected at this site. The coalition report (Johnson and Klassen 2004) suggests that nearby dumping of trash and waste from illegal production of methamphetamines may be the source of this toxicity, and future surveys will be made upstream of the dump site.

Bear Creek

The 303(d) list does not indicate any water quality impairments for Bear Creek. The USGS has very few data for water quality on Bear Creek; only three measurements of diazinon, chlorpyrifos, and dieldrin have been made since 1995. The dieldrin measurements were all non-detects, and none of the diazinon measurements exceeded the 0.05-µg/L criterion. However, one of the chlorpyrifos measurements did exceed the 0.014-µg/L criterion.

Chowchilla River

The 303(d) list does not indicate any water quality impairments for the Chowchilla River. The USGS water quality data for the Chowchilla River (measurement site located below Buchanan Dam) are not useful because the most recent data are from 1965 and the measurement location is outside of the SJVFS boundary.

Fresno River

The 303(d) list does not indicate any water quality impairments for the Fresno River. The USGS water quality data for the Fresno River (measurement site located below Hidden Dam) are not useful because the most recent data are from 1964 and the measurement location is outside of the SJVFS boundary.

San Joaquin River

The lower San Joaquin River was listed on the 303(d) list as being impaired for mercury because elevated levels of methylmercury were detected in fish. The EPA has established a tissue residue criterion of 0.3 mg methylmercury/kg fish. (EPA 2001.)

As discussed above, the San Joaquin River between Friant Dam and Vernalis is listed as impaired for chlorpyrifos, diazinon, boron, DDT, salinity, selenium, mercury, and group A pesticides. Table 3-83 provides a summary of available recent data collected by the USGS in the San Joaquin River at Stevinson and Vernalis for these water quality constituents. Salinity is measured continuously as EC, so instead of appearing in the table, sample EC data for 1995 to 2005 are shown in Figure 3-23a.

Table 3-83. USGS Data for Diazinon, Boron, Chlorpyrifos, and Dieldrin in the San Joaquin River near Stevinson and at Vernalis

	Diazinon	Boron	Chlorpyrifos	Dieldrin
San Joaquin River near Stevinson				
Earliest date	Jan-00	Jun-85	Jan-00	Jan-00
Latest date	Aug-01	Sep-88	Aug-04	Aug-01
Count	62	53	62	62
Average (µg/L)	0.043	159	0.009	0.004
Minimum (µg/L)	0.002	10	0.002	0.001
Maximum (µg/L)	0.289	380	0.140	0.005
Percent Exceedances	27	0	6	0.0
San Joaquin River at Vernalis				
Earliest date	Jan-95	Jan-95	Jan-95	Jan-95
Latest date	Aug-04	Apr-01	Aug-04	Aug-04
Count	218	52	218	219
Average (µg/L)	0.024	251	0.006	0.003
Minimum (µg/L)	0.002	97	0.002	0.001
Maximum (µg/L)	0.235	531	0.055	0.010
Percent Exceedances	11	0	4	0.5

Exceedance criteria were 0.014 µg/L for chlorpyrifos, 0.05 µg/L for diazinon, 600 µg/L for boron, and greater than the detection limit for dieldrin.

The Stevinson site is upstream of Salt Slough. Summertime flows in this part of the San Joaquin River are low and largely derived from small local accretions that could potentially contain relatively high amounts of agricultural runoff. Vernalis is located at the downstream end of the San Joaquin River at the point where it enters the delta. The water quality at Vernalis is the final product resulting from all the tributaries in the San Joaquin River watershed.

The dieldrin detection limits (0.001 µg/L, 0.005 µg/L, and sometimes 0.009 µg/L) were relatively high compared to the criterion (0.00014 µg/L). Only one of the dieldrin measurements had a value above the detection limit, representing 0.5% of the sampling at Vernalis (Table 3-83).

The USGS database did not have any San Joaquin River data for DDT concentrations in the water column. DDT is a hydrophobic organochlorine pesticide that is extremely resilient in the environment and tends to cling to sediment. Thus DDT, and its breakdown, DDE, are typically found in the bed sediment of the river. This analysis only covers data found directly in the water column.

As tabulated by the Central Valley Water Board, of 255 samples collected for diazinon analysis from the San Joaquin River at Vernalis since 2000, about 4% have had diazinon concentrations greater than the acute toxicity target of 0.16 µg/L proposed in the draft modification to the Basin Plan (Central Valley Water Board 2005b). In the San Joaquin River at Stevinson, approximately 2.3% of the 86 samples collected had concentrations above this criterion.

For chlorpyrifos, the Central Valley Water Board reported that approximately 1% of 1,113 samples collected for chlorpyrifos analysis from in the San Joaquin River at Vernalis and 2% of 87 samples collected from in the San Joaquin River at Stevinson since 2000 had chlorpyrifos concentrations greater than the acute toxicity target of 0.025 µg/L (Central Valley Water Board 2005b).

The EC at Vernalis is generally much lower than the EC measured farther upstream at Stevinson, Fremont Ford, and Patterson (Figure 3-23a). These locations are upstream of the relatively clean inflows from the Tuolumne and Stanislaus Rivers. Much of the high EC in the San Joaquin River comes from Salt Slough and Mud Slough, which are located in the DMC Subwatershed and discussed in further detail in that section.

The EC data presented in Figure 3-23a indicate that the EC criteria of 700 µS/cm (April 1–August 31) and 1,000 µS/cm (September 1–March 31) were met in 2004. On occasion the daily values exceeded the criteria, but the criteria are for the running 30-day average value. In previous years, however, the criteria have been exceeded. Between 1986 and 1998 the 700 µS/cm criterion was exceeded approximately 49% of the time and the 1,000 µS/cm criterion was exceeded approximately 11% of the time (Central Valley Water Board 2004).

Mercury measurements for Vernalis are available from the USGS, but they are not shown because the detection limits were higher than the criteria; the measurements were made prior to 1991.

The draft report on the mercury TMDL for the Delta provides some additional information (Central Valley Water Board 2005c). Only about 7% of the methylmercury load to the Delta comes from the San Joaquin River. Thirty-one methylmercury values from samples collected from the San Joaquin River at Vernalis between 2000 and 2004 ranged from 0.093 nanograms per liter (ng/L) to 0.256 ng/L. These values are very low compared to the EPA IRIS (Integrated Risk Information System) reference dose for drinking water of 70 ng/L. Thirty-five measurements of total mercury from samples collected at Vernalis between 1993 and 2004 ranged from 0.003 µg/L to 0.024 µg/L. All of these values were lower than the 0.05-µg/L CTR criteria.

This level has been exceeded in trophic level 4 fish collected at Lander Avenue (between Bear Creek and Salt Slough, also known as Highway 165 near Stevinson), between Crow's landing and Las Palmas Roads (between Orestimba Creek and the Tuolumne River), and near Vernalis. Of 264 fish sampled, the average mercury concentration was 0.45 ppm (Central Valley Water Board 2001).

USGS selenium measurements were available only for the San Joaquin River at Newman. Between 1984 and 1988, 99 samples were collected for analysis of selenium. Concentrations ranged from 1 µg/L (the detection limit) to 11 µg/L, with an average value of 4 µg/L and a 34% exceedance of the 5 µg/L criteria for the 4-day average. The Newman site falls within the small section of the river that is listed as impaired for selenium (3 river miles between Mud Slough and the Merced River).

The TMDL report (Central Valley Water Board 2001b) for selenium in the lower San Joaquin River (downstream of the Merced River) reports that approximately 88% of the selenium load in the San Joaquin River comes from the Drainage Project Area portion of the grassland watershed, which is in the southern portion of the DMC Subwatershed. Average annual selenium concentrations measured between 1986 and 1998 ranged between 0.6 and 3.0 µg/L at Vernalis and between 0.8 and 6.3 µg/L at Patterson. Patterson is upstream of the relatively clean Tuolumne River inflow, so it is not surprising that it has higher selenium concentrations than Vernalis.

San Joaquin River Basin—Delta-Carbona Subwatershed

General Description

The Delta-Carbona Subwatershed is a combination of Calwater regions 75 (Carbona), 43 (North Diablo Range), and 44 (Delta-Carbona Subwatershed). It is located in Contra Costa, Alameda, and San Joaquin Counties. The elevation ranges from –20 feet to 3,832 feet.

The Delta-Carbona Subwatershed encompasses most of the Delta. The San Joaquin River and the North Mokelumne River form the northwestern boundary (Figure 3-24). The eastern boundary runs along Interstate 5 and stays to the east of the San Joaquin River. The subwatershed extends as far south as the Stanislaus River. The San Joaquin River at Vernalis, one of the most studied locations on the San Joaquin River, is about 2 miles north of the boundary of the San Joaquin Valley Floor Subwatershed. Conditions at this location are mentioned in that subwatershed report and will be mentioned in this report for the Delta-Carbona Subwatershed. The western boundary of the Delta-Carbona Subwatershed is on the inland edge of the coastal range.

The Delta is a complex web of waterways winding among agricultural islands that are close to or below sea level. Flows and water quality in the Delta are influenced primarily by:

- major inflows—the San Joaquin River, the Sacramento River, and ocean tides;
- major outflows—exports to the California Aqueduct at the Banks pumping plant and to the DMC at the Tracy pumping plant; and

- channel structure—channel dimensions and slope as well as the use of gates and construction of barriers such as the one used at the head of Old River to modify the flow split at the intersection of the San Joaquin River and Old River.

Smaller inflows and diversions (such as Marsh Creek, the Calaveras River, the Mokelumne River, and agricultural diversions and returns) also play a role in influencing flow and water quality.

Flows in the Delta are difficult to measure because the tidal influence means that there is no meaningful relationship between stage and flow. The USGS, however, has been using acoustic doppler to measure flow at some locations. Table 3-84 shows the minimum, mean, and maximum of the monthly average values for data measured between 1995 and 2004. Most of these locations have tidal flow so that flow usually moves both downstream (positive flow) and upstream (negative flow) within a day.

The Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (State Water Board 1995) has standards for some of the biggest factors in Delta hydraulics: Delta outflow, Sacramento and San Joaquin River inflows, Delta exports, and Delta Cross Channel gate position.

The jurisdiction of the San Joaquin County and Delta Water Quality Coalition covers much of the Delta-Carbona Subwatershed, extending from the western edge of the Delta to the eastern edge of San Joaquin County and from the Mokelumne River to the Stanislaus River. The Contra Costa Water District straddles the western edge of the Delta-Carbona Subwatershed. This water district obtains drinking water from the Delta and is vigilant about Delta water quality. The West Side Irrigation District, the Plain View Water District, and the Banta-Carbona Irrigation District all operate within in the southern portion of the Delta-Carbona Subwatershed.

The climate of the Delta-Carbona Subwatershed is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F and winter temperatures are only occasionally below freezing. The Delta weather conditions are more moderate than in the rest of the Central Valley because of the moderating effect of the proximity of the ocean. The winter snowpack, which accumulates above 5,000 feet elevation (which is outside of this subwatershed) primarily in the Sierra Nevada Mountains, supplies the vast majority of water in the basin.

There are numerous waterways within the Delta-Carbona Subwatershed. Some of the larger ones, or ones that are of particular water quality concern, are described briefly below.

Downstream San Joaquin River

The downstream end of the San Joaquin River enters the southern end of the Delta-Carbona Subwatershed near its confluence with the Stanislaus River. It then flows north to the flow split at Old River, where there is sometimes a significant reduction in flow depending on the position of Delta barriers and the level of Delta exports. By this point, the river is tidally influenced. At Stockton the San Joaquin River turns into the Deep Water Ship Channel (DWSC), which is dredged to allow passage of large cargo ships to the Port of Stockton. After passing through a web of Delta channels, the river terminates near the city of Antioch, where it merges with the Sacramento River.

In the past 20 years, average monthly flows at Vernalis have been as low as about 1,000 cfs during the summer (Table 3-84). The Vernalis flows are generally much less than the Sacramento River flows. Net flows near the downstream end of the San Joaquin River at Jersey Point are often similar to the flows at Vernalis, but a lot happens to the water between the two locations. Generally, some of the Vernalis flows go to the export pumps in the south Delta and some of the Sacramento River flows contribute to flows in the central and south Delta. Depending on flows in the San Joaquin River and the amount of exports, net flows at Jersey Point are sometimes negative.

Downstream Calaveras River

The downstream end of the Calaveras River experiences some of the same water quality problems (diazinon and low DO) that occur in other portions of the Delta-Carbona Subwatershed. This impaired section of river falls mostly within the Delta-Carbona Subwatershed although it extends upstream into the North Valley Floor Subwatershed.

Old River

Old River is basically a long, convoluted side channel of the San Joaquin River. The southern potion of Old River, which flows east to west from the San Joaquin River to the DMC, has tidal flows, but depending on flows and barriers, the net flow within this section of Old River can be very low (Jones & Stokes 2005 Mountain House Report).

North of the export pumps, Old River flows south to north from Clifton Court Forebay to Franks Tract and on to the San Joaquin River. Because of Delta exports, net flow in this section of river is often negative (i.e., in the upstream direction) (Table 3-84).

Middle River

Middle River starts near the upstream end of Old River. It then heads northwest, intersects many side channels, passes by flooded Mildred Island, and connects with the San Joaquin River. The southern portion of Middle River between Old River and Trapper Slough has relatively low flows because of its narrow, constricted channel. Farther north, Middle River carries significant flows, often toward the export pumps (Table 3-84).

Marsh Creek

Marsh Creek is a small tributary to the Delta, but it is significant because of its relatively high concentration of mercury. Marsh Creek originates on the eastern slopes of Mount Diablo. It merges with Dunn Creek, which carries mercury from the Mount Diablo Mine. Marsh Creek runs into a small reservoir, Marsh Creek Reservoir, and then flows north into Big Break and the downstream end of the San Joaquin River near Jersey Point. Daily flows in the USGS database for September 2000–October 2004 for Marsh Creek near Brentwood ranged between 0.4 and 590 cfs, with an average of 8 cfs.

Eastern Side Channels

There are several side channels on the eastern edge of the Delta that have specific water quality issues. These are listed here in north to south order:

- **Mosher Slough**—Located at the northern edge of Stockton, it connects with Bear Creek at its downstream end and receives flow from Mosher Creek at its upstream end.
- **Five Mile Slough**—Originates in Stockton and extends to Fourteen Mile Slough.
- **Smith Cana**l—Originates in Stockton and ends at the Stockton DWSC.
- **Turning Basin**—the extension of the Stockton DWSC that is not part of the San Joaquin River; the Turning Basin allows ships to enter the Port of Stockton and provides room for turning around.
- **Mormon Slough**—Originates as a diversion from the Calaveras River at Bellota. It passes through Stockton and connects to the southern edge of the Turning Basin. Two sections of Mormon Slough have water quality issues. Commerce Street is located near the boundary between the Delta-Carbona Subwatershed and the North Valley Floor Subwatershed and it is the dividing line for the two impaired sections of Mormon Slough. As a result, the downstream portion, from Commerce Street to the Turning Basin, is included in the Delta-Carbona Subwatershed, whereas the upstream portion is included in the North Valley Floor Subwatershed.

Walker Slough is also an eastern side channel to the Delta, but it is predominantly outside of the Delta-Carbona Subwatershed, so it is included with its upstream watershed in the description of the North Valley Floor Subwatershed.

Table 3-84. San Joaquin River Flows (cfs) Measured from 1995 through 2004

	San Joaquin River near Vernalis			Grant Line Canal at Tracy Boulevard[a]			Middle River at Middle River			Old River at Bacon Island			San Joaquin River at Jersey Point		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	1,792	5,911	30,377	1,456	1,519	1,603	-5,059	-1,075	11,992	-3,934	-1,226	10,550	6,086	20,788	81,847
Feb	1,879	10,954	35,057	1,254	1,898	3,338	-4,713	177	11,359	-3,890	22	9,304	2,025	26,079	69,726
Mar	2,134	9,362	19,352	1,364	2,635	5,184	-4,878	-869	4,294	-2,823	357	3,895	492	15,664	35,201
Apr	2,598	7,657	21,937	1,020	1,096	1,172	-2,590	-984	5,269	-1,649	190	4,667	-1,008	9,261	33,464
May	2,625	7,524	22,187	413	769	1,125	-2,333	-708	2,969	-785	351	3,503	2,821	9,085	26,572
Jun	1,404	5,034	17,760	139	139	139	-5,715	-2,927	1,877	-2,802	-1,405	2,075	1,491	7,319	24,083
Jul	1,147	3,613	13,193	70	275	481	-5,755	-4,754	-848	-4,438	-3,234	-18	-517	3,060	11,638
Aug	1,116	2,227	5,442	-37	231	500	-5,808	-4,951	-3,556	-4,682	-3,661	-2,321	-1,579	2,099	7,143
Sep	1,121	2,407	5,758	-48	-48	-48	-5,580	-4,716	-3,318	-3,933	-3,018	-1,558	1,342	2,937	5,403
Oct	1,705	3,145	6,153	-33	279	590	-4,731	-3,508	-2,620	-3,438	-2,375	-1,473	222	3,796	8,054
Nov	1,647	2,284	3,290	696	919	1,142	-4,522	-3,223	-1,467	-3,291	-2,301	-864	2,554	4,256	5,612
Dec	1,503	3,374	12,192	1,328	1,375	1,412	-4,779	-2,936	-80	-3,686	-1,903	152	37	6,894	21,292

[a] Data collected 2000–2004. For April–November there were only 1 to 2 years with flow measurements.

Data for all locations except Vernalis had gaps.

Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Irrigated agriculture is the primary land use type in the Delta-Carbona Subwatershed. DWR land use types such as citrus and subtropical, deciduous fruits and nuts, grain and hay crops, pasture (which may or may not be irrigated), rice, semiagriculture and incidental to agriculture, truck, nursery, and berry crops, and vineyards, and FRAP land use type agriculture combine for 311,811 acres or 46.9% of the subwatershed area. Second to irrigated agriculture is native vegetation, which covers 227,237 acres, or 34.2% of the subwatershed. Native vegetation includes DWR land use types native vegetation and riparian vegetation and FRAP land use types hardwood, herbaceous, and shrub. Urban land use, including commercial, industrial, residential, urban and urban landscape DWR and FRAP land use type agriculture, occupies 68,532 acres (10.3%). Water, a combination of DWR land use type surface water and FRAP land use type water, covers 42,217 acres or 6.35%. DWR land use types barren and wasteland, idle, and vacant, combined for 14,952 acres of barren land (2.25%). The remaining 10 acres are FRAP land use type wetlands. For individual land use type acreages see Table 3-85. (Figure 3-36.)

Table 3-85. Land Use Acreage according to DWR and FRAP Land Use Data for the Delta-Carbona Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	54	0.008
Deciduous Fruits and Nuts	17,956	2.701
Field Crops	106355	15.999
Grain and Hay	47,504	7.146
Idle	5,608	0.844
Pasture	61,451	9.244
Rice	801	0.120
Semiagricultural and Incidental	3916	0.589
Truck, Nursery, and Berry Crops	62,539	9.408
Vineyards	8,637	1.299
Subtotal	314,821	47.358
Urban		
Urban—unclassified	53,940	8.114
Urban Landscape	2,209	0.332
Urban Residential	3,539	0.532
Commercial	902	0.136
Industrial	6,707	1.009
Vacant	9,284	1.397
Subtotal	76,581	11.52
Native		
Barren and Wasteland	60	0.009
Native Vegetation	177,507	26.702
Riparian Vegetation	8,713	1.311
Water Surface	41,948	6.310
Subtotal	228,228	34.332
FRAP Land Use Type		
Agriculture	2,598	0.391
Hardwood	5,667	0.852
Herbaceous	35,212	5.297
Shrub	138	0.021
Urban	1,235	0.186
Water	269	0.040
Wetland	10	0.001
Subtotal	45,129	6.788
Total	**664,759**	**100**

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Delta-Carbona Subwatershed. Table 3-86 lists the beneficial uses of the Sacramento–San Joaquin River Delta.

Table 3-86. Beneficial Uses of the Sacramento–San Joaquin River Delta

Beneficial Uses	Sacramento–San Joaquin River Delta
Municipal & Domestic	E
Irrigation	E
Stock Watering	E
Process	E
Service Supply	E
Power	
Rec-1 (Contact)	E
Rec-2 (Noncontact)	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	E
Migration—Cold	E
Spawning—Warm	E
Spawning—Cold	
Wildlife Habitat	E
Navigation	E

P = Potential, E = Existing, U = Undefined.
Source: Data obtained from the Sacramento San Joaquin River Basin Plan.

Impaired Status

The CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. Within the Delta-Carbona Subwatershed, there are 16 waterways that are listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003 (Table 3-87).

According to the 303(d) list of water quality–impaired rivers, much of the Delta is listed as impaired for chlorpyrifos, diazinon, DDT, group A pesticides, mercury, and unknown toxicity. Some sections of the Delta are listed as impaired for low DO, with the impairment in the DWSC being the highest concern. Some of the eastern side channels (Smith Canal, the lower Calaveras River, Five Mile Slough, Mormon Slough, and Mosher Slough) are listed as impaired for pathogens. The DWSC Turning Basin is listed as impaired for several unique water quality constituents—dioxin, furan compounds, and PCBs.

Agriculture is listed as the potential source for the elevated levels of DDT, EC, and group A pesticides. The combination of agriculture, urban runoff, and storm sewers is given as the potential sources for chlorpyrifos and diazinon. High levels of metals and mercury most likely come from abandoned mines. The waterways listed as impaired for pathogens run through urban Stockton, so urban runoff, storm sewers, and recreational and tourism activities are listed as potential sources. In the Turning Basin, dioxin and PCBs may be coming from point sources and furan compounds may be coming from contaminated sediment.

The 303(d) list shows municipal point sources, urban runoff, and storm sewers as being the potential sources for organic enrichment/low DO. Channel hydraulics and high levels of nutrients and algae from upstream waterway can also play a role in low DO. The 303(d) list does not include organic enrichment with the low DO impairment in Middle River and Old River. In these two rivers, the sources of the DO problem are listed as hydromodification and source unknown. The DO Amendment was adopted by the Central Valley Water Board, but still needs final approval from the State Board Office of Administrative Law.

Table 3-88 presents some of the Federal and State criteria for water quality constituents that are included in the CWA Section 303(d) listed waterways in the SJVFS. Dieldrin is chosen to represent the group A pesticides because it is the only one that is measured in the water column as opposed to the remaining group A pesticides which are measured in sediment. Mercury criteria are either for total or inorganic mercury.

Table 3-87. Impaired Designations by River Sub-Areas

	Chlorpyrifos	Diazinon	DDT	Group A Pesticides	Mercury	Unknow Toxicity	Organic Enrichment/ Low DO	Pathogens	EC	Metals	Organo-phosphorus Pesticides	Dioxin	Furan Compounds	PCBs
Delta Waterways (Eastern Portion)—20,135 acres														
	H	H	L	L	M	L								
Delta Waterways (Stockton Ship Channel)—952 acres														
	H	H	L	L	M	L	H							
Turning Basin—3.3 miles														
								M				L	L	L
Delta Waterways (Western Portion)—22,904 acres														
	H	H	L	L	M	L			M					
Old River (San Joaquin River to DMC)—15 miles														
							L							
Middle River—9.7 miles														
							L							
Smith Canal—2.4 miles														
							L	L			M			
Lower Calaveras River—5.8 miles														
		L					L	L						
Five Mile Slough (Alexandria Place to Fourteen Mile Slough)—1.6 miles														
	M	M					L	L						
Mormon Slough (Commerce Street to Stockton Deep Water Channel)—0.93 miles														
							L	M						
Mosher Slough (downstream of I-5)—1.3 miles														
	M	M					L	L						
Mosher Slough (downstream of I-5)—3.5 miles														
								L						
Dunn Creek (Mt Diablo Mine to Marsh Creek)—0.7 miles														
					L					L				

	Chlorpyrifos	Diazinon	DDT	Group A Pesticides	Mercury	Unknow Toxicity	Organic Enrichment/ Low DO	Pathogens	EC	Metals	Organo-phosphorus Pesticides	Dioxin	Furan Compounds	PCBs
Marsh Creek (Dunn Creek to Marsh Creek Reservoir)—11 miles														
										L				
Marsh Creek (Marsh Creek Reservoir to San Joaquin River)—10 miles														
					L					L				
Marsh Creek Reservoir—278 acres														
					L									

L, M, and H indicate low, medium, and high priority, respectively.

indicates that impairment was only for DO and not organic enrichment.

Table 3-88. Water Quality Criteria

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)		
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL	CDHS Action Level	CTR
Diazinon	0.05	0.08	0.10	0.10	0.600	6.000	NA
Chlorpyrifos	0.014	0.02	0.041	0.083	20.00	NA	NA
Dieldrin (Group A Pesticides)	NA	NA	0.056	0.24	0.5	0.002	0.00014
Mercury	NA	NA	0.77 (total)	1.4 (total)	2.0 (inorganic)	NA	0.05 (total)
DDT	NA	NA	.001	NA	NA	NA	0.00059
PCBs	NA	NA	0.014	NA	NA	NA	0.00017

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. CTR values are the 30-day average values for drinking water for the California Toxics Rule.

Sources: EPA 2003, 2004; Siepman and Finlayson 2000; Federal Register; Central Valley Water Board 2005. The EPA has established a tissue residue criterion of 0.3 mg methylmercury/kg fish (EPA 2001).

The Basin Plan also has water quality criteria for some of the 303(d) constituents of concern for the Delta-Carbona Subwatershed. They are as follows:

- **EC**—The Basin Plan has various criteria for EC in the Delta. The criteria depend on location, time of year and water year type. Criteria for the western and interior portions of the Delta, which receive some influence from the freshwater Sacramento River, start at 450 µmhos and increase for drier years. Criteria in the south Delta and at the export pumps at Tracy and Banks pumping plants range between 700 and 1,000 µmhos. This area is more influenced by the relatively salty San Joaquin River. During April and May there are some additional criteria for striped bass spawning at the downstream end of the San Joaquin River between Prisoners Point and Antioch.
- **DO**—In general, the Basin Plan criterion for DO in the Delta-Carbona Subwatershed is that DO levels should remain above 5.0 mg/L. However, in the DWSC between Stockton and Turner Cut, the DO levels should remain above 6.0 mg/L from September 1 through November 30.
- **Bacteria (pathogens)**—The Basin Plan currently has two objectives for fecal coliform bacteria. The geometric mean concentration should not exceed 200 per 100 ml, and the 90th percentile should not exceed 400 per 100 ml. For this analysis, data should exist for at least five measurements in a 30-day period. In 2002, the Central Valley Water Board adopted a modification to these objectives. This modification is waiting approval from other agencies (Central Valley Water Board 2002). The modified objectives replace fecal coliform measurements with *E. coli* measurements. The geometric mean of *E. coli* concentrations should not exceed 126 per 100 ml, and no sample should exceed 235 per 100 ml. The 126 per 100 ml objective is the same as listed in EPA guidelines, and the 235 per 100 ml objective is in guidelines from the CDHS (Central Valley Water Board 2001).

- **Chlorides**—Although the Delta is not listed on the 303(d) list as impaired for chlorides, chloride levels are a concern for water exported for drinking water and agricultural purposes. The Basin Plan has chloride objectives for the Contra Costa Canal pumping plants, the Antioch waterworks intake, Clifton Court Forebay, the DMC, the City of Vallejo intake, and the North Bay aqueduct intake.

Both the Basin Plan and the Basin Plan for the Delta and the San Francisco Bay (1995 Basin Plan) (State Water Board 1995) have water quality objectives for the Delta, which generally are in agreement with each other. Unlike the Basin Plan, the 1995 Basin Plan also has objectives for EC in Suisun Marsh and the major Delta inflows and outflows. The 1995 Basin Plan undergoes periodic review. In the future, water quality objectives for the Delta may change as a result of this review process (State Water Board 2004).

Since the creation of the Basin Plan, the process of establishing TMDLs has been initiated for several water quality constituents. Once a TMDL is finalized, it is implemented by an amendment to the Basin Plan. For the Delta, there is a draft TMDL report for methyl and total mercury (Central Valley Water Board 2005b) and a final Basin Plan amendment for the control of factors contributing to the low DO problem in the Stockton DWSC (Central Valley Water Board 2005c).

There are various TMDLs under development, but not all of them require Basin Plan amendments. The Central Valley Water Board has amended the Basin Plan for diazinon and chlorpyrfos, and is currently pending approval from the State Board Office of Administrative Law. The Central Valley Water Board staff are currently developing the Delta TMDL for the control of diazinon and chlorpyrifos. For the lower San Joaquin River, there is a draft amendment to the Basin Plan for the control of diazinon and chlorpyrifos (Central Valley Water Board 2005d). The draft amendment for diazinon and chlorpyrifos includes new proposed acute toxicity targets of 0.16 μg/L for diazinon and 0.025 μg/L for chlorpyrifos. As the TMDLs for the upstream watersheds are implemented, it is likely that water quality conditions in the Delta will improve.

Water Quality

Numerous waterways in the Delta-Carbona Subwatershed are included in the 303(d) list of impaired waters. Many of these waterways are listed as impaired for the same water quality constituents. In order to prevent redundancy, this section of the Delta-Carbona Subwatershed report will be organized differently from Water Quality sections in the other subwatershed reports—by water quality constituent instead of waterway.

Delta water quality conditions can vary dramatically because of year-to-year differences in runoff and water storage releases and seasonal fluctuations in Delta flows. Concentrations of materials in the river inflows are often related to streamflow volume and season. Transport and mixing of materials in Delta channels are strongly dependent on river inflows, tidal flows, agricultural diversions, drainage flows, wastewater effluents, and exports.

Some general Delta water quality issues include the following (Jones & Stokes 2005):

- High-salinity water from Suisun Bay intrudes into the Delta during periods of low Delta outflow. Salinity adversely affects agricultural, municipal, recreational, and industrial uses.
- Delta exports have elevated concentrations of disinfection by-product precursors (e.g., dissolved organic carbon [DOC]), and the presence of Br^- increases the potential for formation of brominated compounds in treated drinking water.
- Agricultural drainage in the Delta contains high levels of nutrients, suspended sediments (SS), DOC, and minerals (salinity), as well as traces of agricultural chemicals (pesticides).
- Synthetic and natural contaminants have bioaccumulated in Delta fish and other aquatic organisms. Synthetic organic chemicals and heavy metals are found in Delta fish in quantities occasionally exceeding acceptable standards for food consumption.

The San Joaquin River delivers water of relatively poor quality to the Delta, with agricultural drainage to the river being a major source of salts and pollutants (e.g., boron, selenium, pesticides). Because the south Delta receives a substantial portion of its water from the San Joaquin River, the influence of this relatively poor San Joaquin River water quality is greatest in the south Delta channels and in the SWP and CVP exports.

In 2004, the San Joaquin County & Delta Water Quality Coalition began monitoring water quality (Johnson 2005). One site was in the Delta-Carbona Subwatershed, and the rest were farther east. Future monitoring will cover more sites in the Delta-Carbona Subwatershed providing useful information.

Most of the water quality data described below comes from individual reports. The Interagency Ecological Program (IEP) and CDEC time series databases have good records of flow, stage, and EC in the Delta. However, data for other water quality constituents, particularly contaminants, are limited. The USGS and BDAT web sites have a lack of recent data for the water quality constituents of concern in the Delta, although there are fairly good data for the San Joaquin River at Vernalis. The San Francisco Estuary Institute has a good set of water quality data. However, the coverage of their database is mostly limited to the San Francisco Bay and extends only as far east as the city of Antioch.

As part of this evaluation, the percent of measurements exceeding a threshold were calculated. The thresholds were generally the lowest criteria present on Table 3-87. Because the criteria selected may not be applicable to a particular water body, the purpose of this calculation is only to produce a general indicator of elevated concentrations, not to detect water quality violations. For example, a particular river may not be a source of drinking water, but exceedances of a drinking water criterion are indicative of potential problems in that watershed or downstream.

The water quality discussion below focuses primarily on the water quality constituents included in the 303(d) list.

Chlorpyrifos and Diazinon

The CWA 303(d) list indicates that most of the Delta has elevated levels of chlorpyrifos and diazinon. Some specific portions of the Delta are singled out: Five Mile Slough and Mosher Slough. In addition, Smith Canal is listed as having high levels of organophosphorus pesticides based on toxicity testing. These organophosphorus pesticides include diazinon and chlorpyrifos (Central Valley Water Board 2001).

Diazinon and chlorpyrifos have been of particular concern in the Delta-Carbona Subwatershed. These organophosphorus pesticides are typically applied during the winter dormant season, with chlorpyrifos use extending into the spring. Wintertime surveys of these insecticides indicated that some of the higher concentrations occur in some of the smaller tributaries (USGS 2002) and that concentrations in precipitation were very high (USGS 2003). River concentrations of these chemicals tend to be highest during the beginning part of a storm event (USGS 2003).

The Central Valley Water Board has developed the San Joaquin River TMDL for the control of diazinon and chlorpyrifos and was adopted November of 2005. The Central Valley Water Board has written a draft amendment to the Basin Plan for the control of diazinon and chlorpyrifos runoff into the lower San Joaquin River (Central Valley Water Board 2005d). Diazinon and chlorpyrifos concentrations measured from 1991 through 2005 were compiled for the draft amendment and compared to proposed acute toxicity targets of 0.16 µg/L for diazinon and 0.025 µg/L for chlorpyrifos. These values are higher than the DFG acute criteria of 0.08 µg/L for diazinon and 0.02 µg/L for chlorpyrifos (Table 3-88).

During the past 10 years, the use of diazinon and chlorpyrifos in the SJVFS has decreased substantially (USGS 2002). The concentration of these pesticides in the rivers has also decreased (Central Valley Water Board 2005d). In recent years, pyrethroids have been replacing some organophosphate use. Pyrethroids tend to bind with organic material and may be more likely to be present in sediment than in water (ESJWQC 2004).

Table 3-89 presents measurements of diazinon and chlorpyrifos at Vernalis (from the USGS database) and Antioch (from the SFEI database). The data suggest that concentrations of diazinon and chlorpyrifos are higher in the southern part of the Delta than they are closer to the ocean.

Table 3-89. Data for Diazinon and Chlorpyrifos in the San Joaquin River near Vernalis and Antioch

	Diazinon		Chlorpyrifos	
	Vernalis	Antioch	Vernalis	Antioch
Earliest date	Jan-00	Feb-95	Jan-00	Feb-95
Latest date	Aug-01	Jul-02	Aug-04	Jul-02
Count	62	16	62	17
Average (µg/L)	0.043	0.007	0.009	0.0003
Minimum (µg/L)	0.002	0.000	0.002	0.0000
Maximum (µg/L)	0.289	0.031	0.140	0.0008
Percent Exceedances	27	0.0	6	0.0

Exceedance criteria were 0.05 µg/L for diazinon and 0.014 µg/L for chlorpyrifos.

As tabulated by the Central Valley Water Board, of 255 samples collected for the analysis of diazinon from the San Joaquin River at Vernalis since 2000, about 4% have had diazinon concentrations greater than the acute toxicity target of 0.16 µg/L proposed in the draft modification to the Basin Plan (Central Valley Water Board 2005d). For chlorpyrifos, the Central Valley Water Board reported that approximately 1% of 1,113 samples collected for the analysis of chlorpyrifos from the San Joaquin River at Vernalis since 2000 had chlorpyrifos concentrations greater than the acute toxicity target of 0.025 µg/L (Central Valley Water Board 2005d).

Dichlorodiphenyltrichloroethane (DDT)

The CWA Section 303(d) list indicates that most of the Delta has elevated levels of DDT. There is a lack of data for DDT concentrations in the water column. DDT is a hydrophobic organochlorine pesticide that is extremely resilient in the environment and tends to cling to sediment. Thus DDT and its breakdown DDE are typically found in the bed sediment of the river. This report focuses on water quality conditions in the water column.

The SFEI has measured the various forms of DDT in the water near Antioch. A summary of the total DDT measurements is shown in Table 3-90.

Table 3-90. Summary of Total DDT Data Collected by SFEI near Antioch

	DDT
Earliest Date	Feb-95
Latest Date	Aug-03
Count	18
Average (pg/L)	247
Minimum (pg/L)	73
Maximum (pg/L)	754
Percent Exceedance	5.6

pg/L = picograms per liter.
The exceedance criterion was 590 pg/L.

Group A Pesticides

The CWA 303(d) list indicates that most of the Delta has elevated levels of Group A pesticides.

The dieldrin detection limits for historical measurements are usually relatively high, 0.001 µg/L, 0.005 µg/L, and sometimes 0.009 µg/L reported in the USGS water quality database. This is much higher than the CTR criteria (0.00014 µg/L, or 140 pg/L) (Table 3-88).

The SFEI, however, has measured dieldrin concentrations at lower concentrations. Table 3-91 presents a summary for samples collected by SFEI near Antioch. The concentrations of dieldrin in these samples were greater than the CTR criteria of 140 pg/L in about 5% of the samples, indicating the persistent presence of dieldrin in the Delta. However, The criterion is for a 30-day average for drinking water. Given that the overall average concentration of the 19 samples was 58 pg/L, and the data were not presented to determine the 30-day average, a determination of whether or not the criterion were met is not possible.

Table 3-91. Summary of Dieldrin Data for the San Joaquin River near Antioch

	Dieldrin
Earliest Date	Feb-95
Latest Date	Aug-03
Count	19
Average (pg/L)	58
Minimum (pg/L)	1
Maximum (pg/L)	220
Percent Exceedance	5.3

The exceedance criterion was 140 pg/L.

Mercury and Metals

The CWA 303(d) list indicates that most of the Delta has elevated levels of mercury. In addition, Marsh Creek (a tributary to the Delta) and Dunn Creek (a tributary to Marsh Creek) are listed as impaired for mercury and metals.

The draft report on the mercury TMDL for the Delta provides good information about mercury conditions in the Delta (Central Valley Water Board 2005b). Approximately 80% of the total mercury load for the Delta comes from the Sacramento River basin.

Methylmercury concentrations in the Delta are usually below 0.3 ng/L. Between March 2000 and April 2004, the highest concentration recorded was 0.7 ng/L at Prospect Slough. All of the concentrations recorded are very low compared to the EPA IRIS reference dose for drinking water of 70 ng/L.

The CTR criterion for total mercury is 0.05 µg/L. Within the Delta, this value has been exceeded only occasionally: at French Camp Slough near Airport Way, Prospect Slough (Yolo Bypass), Sacramento River at Greene's Landing, Sacramento River at RM 44, and Ulatis Creek near Main Prairie Road. However, the criterion is for a 30-day average. Using regression relationships between total mercury grab sample data and flow, time series of total mercury concentrations were estimated. Based on these results, the CTR criterion is likely met at all the sample locations in the Delta except for, perhaps, Marsh Creek and Prospect Slough (Central Valley Water Board 2005b).

The Delta was listed in the 303(d) list as being impaired for mercury because elevated levels of methylmercury were detected in fish. The EPA has established a tissue residue criterion of 0.3 mg methylmercury/kg for fish (EPA 2001). Methylmercury levels exceeded this level throughout the periphery of the Delta, but not in the central Delta.

Organic Enrichment/Low Dissolved Oxygen

DO is often used as an indicator of the balance between sources of oxygen (e.g., aeration and photosynthesis) and the consumption of oxygen in decay and respiration processes (mostly from algae). Water with high oxygen demand may come from treated wastewater, agricultural runoff, and stormwater. These water sources also likely add nutrients to the San Joaquin River or Delta, which can cause algal growth. The DO saturation concentration changes with temperature, and DO concentration often varies diurnally. Deep channels are more likely to have low DO because of poor surface aeration (low surface to volume ratio), a lack of light at the greater depths (preventing photosynthesis), and low velocity. DO concentrations in Delta channels are not generally considered to be a problem, except near Stockton and in some dead-end sloughs.

Because the DO concentrations in the DWSC and other south Delta channels are a very important water quality issue, some recent historical DO measurements from the San Joaquin River at Mossdale, Stockton DWSC, and other south Delta channels are presented and described here.

Figure 5.3-7 presents the daily average DO concentrations in the San Joaquin River at Mossdale and in the Stockton DWSC for 2000 and 2001 (data from CDEC). DO concentrations from other south Delta locations are also presented (data from DWR Central District data files). The DO concentrations in the San Joaquin River upstream of Mossdale are generally near DO saturation values (i.e., minimum of about 8 mg/L at 25ºC), because the re-aeration from the river turbulence is strong enough to maintain relatively high DO concentrations. The DO concentrations in the Stockton DWSC are generally the lowest, with several episodes of DO concentrations of less than 5 mg/L. Low DO in the DWSC is attributed to low flows, high organic loading, and deep channel geometry.

The DO measured in south Delta channels was generally higher than in the Stockton DWSC, although several episodes of reduced DO were recorded. Because the tidal flow velocities in the south Delta channels are relatively high, the severe DO depletion that has been measured in the DWSC is not expected to occur regularly in the south Delta channels.

There are eight portions of the Delta that are listed as impaired for low DO. They are the DWSC, Old River (from the San Joaquin River to the DMC), Middle River (from Old River to Trapper Slough), the lower Calaveras River, Five Mile Slough, Mormon Slough, Mosher Slough, and Smith Canal.

DO impairment in the Delta has been studied more in the DWSC than in any other location in the Delta. The DO problem in the DWSC occurs primarily between Channel Point (which is the beginning of the DWSC) and Turner Cut. DWR has been measuring DO at the downstream end of Rough & Ready Island since 1983. During all months, DO concentrations have fallen below 5.0 mg/L, with the worst DO problems occurring from June through October, particularly during dry years. The monthly average percent of time that DO levels fell below 5.0 mg/L varied between 3% in November to 37% in August. During some months the DO concentration never exceeded 5 mg/L (Central Valley Water Board 2005c).

The low DO in Old River and Middle River is of less priority than the low DO in the DWSC. The low DO in these channels probably results from some of the same factors affecting the DWSC—relatively high concentrations of algae and oxygen-demanding substances in combination with reduced tidal flushing—although these channels are not nearly as deep as the DWSC.

The lower Calaveras River, Five Mile Slough, Mormon Slough, Mosher Slough, and Smith Canal pass through the Stockton urban area. The most likely cause of low DO in these waterways is oxygen-demanding substances from urban runoff (Central Valley Water Board 2001). In recent years (1995–2000), DO was below 5 mg/L in 18 of 44 samples collected from the lower Calaveras River, in 24 of 41 samples collected from Five Mile Slough, in 27 of 30 samples collected from Mormon Slough, and in 19 or 43 samples collected from Mosher Slough. In

Smith Canal, several studies indicate an impairment, especially during rain events (Central Valley Water Board 2001).

Pathogens

The waterways in the Delta-Carbona Subwatershed that are included in the 303(d) list as impaired for pathogens are: the Turning Basin, Smith Canal, the lower Calaveras River, Five Mile Slough, Mormon Slough, and Mosher Slough. The presence of pathogens in these waterways is likely caused by their proximity to the Stockton urban area.

These waterways were listed as impaired for pathogens based on *E. coli* measurements collected during 2000–2001. These measurements are described in Appendix A of the report on recommended changes to the CWA Section 303(d) list (Central Valley Water Board 2001), and they are summarized below in Table 3-92. At most locations the proposed criterion of 126 per 100 ml for the geometric mean *E. coli* concentration was exceeded. In every case where this criterion was not exceeded, at least one of the samples exceeded an *E. coli* concentration of 235 per 100 ml, which is the criterion for individual samples.

Table 3-92. Concentrations of E. Coli

Waterway	Location	Geometric Mean of E. Coli Measurements per 100 ml
Lower Calaveras River	Near mouth	76
	4 miles upstream from mouth	322
Five Mile Slough	Near 14 Mile Slough	38
	1.5 miles upstream of mouth at Alexandria Place	147
Mormon Slough	1 mile upstream of DWSC	1272
Mosher Slough	3 Location	Not calculated, but almost all measurements were greater than 126
Smith Canal	At Yosemite Lake	919
	¼ mile downstream of Yosemite Lake	6,223
	Near mouth (Near I-5)	88
Turning Basin	McLeod Lake	287
	Morelli Park	399

Electrical Conductivity

As described above, the Basin Plan has objectives for EC at multiple locations. The 303(d) list indicates that the western portion of the Delta has impaired EC values.

EC is a general measure of dissolved minerals (i.e., salinity) and is the most commonly measured variable in Delta waters. Several water quality objectives have been established for EC values at specific locations in the Delta. High salinity can have a detrimental effect on agricultural production and can cause unpleasant taste and health concerns in drinking water. EC is generally considered a conservative parameter, not subject to sources or losses internal to a water body. Therefore, changes in EC values can be used to interpret the movement of water and the mixing of salt in the Delta. In general, EC values increase with evaporation, decrease with rainfall, and may be elevated in agricultural drainage flows in the Delta. Because EC changes with temperature, Delta EC measurements are standardized to 25°C.

Seawater intrusion from the modeled downstream boundary of the Delta at Martinez (i.e., Benicia) has a large effect on salinity in the Suisun Bay portion of the estuary. The estuarine entrapment zone, an important aquatic habitat region associated with high levels of biological productivity, is defined by the mean daily EC range of about 2–10 millisiemens per centimeter (mS/cm) (Arthur and Ball 1980). The location of the estuarine salinity gradient and associated entrapment zone is estimated from EC monitoring data and is directly related to Delta outflow. The 1995 Basin Plan (State Water Board 1995) includes objectives for the location of the 2 ppt salinity gradient within the estuary, which is measured with a series of EC stations (i.e., Collinsville, Mallard Slough, Port Chicago).

The EC at Vernalis demonstrates a dilution effect as flow increases (Figure 3-24a), indicating that the source of salinity from the San Joaquin River watershed (i.e., agricultural drainage) does not change rapidly with stormwater runoff. The daily EC values at Vernalis are generally less than 750 µS/cm during the summer irrigation season, and are usually less than 1,000 µS/cm for the remainder of the year. The south Delta EC values can be higher than the Vernalis EC because additional salinity from agricultural drainage enters the south Delta channels downstream of Vernalis. Salt is added by the Stockton wastewater treatment plant discharge near the Stockton DWSC and by the Tracy wastewater discharge into Old River.

The Basin Plan salinity objectives at Vernalis specify that the maximum EC will be 700 µS/cm during the irrigation season of April–August (30-day moving average). The maximum EC objective is 1,000 µS/cm during the remainder of the months. Releases from New Melones Reservoir are used by Reclamation to control the salinity at Vernalis, but there is a maximum specified volume of water reserved for this purpose.

The Basin Plan also specifies that the Vernalis EC objectives should be met at three south Delta locations—San Joaquin River at Brandt Bridge (located 6 miles downstream of the head of Old River), Old River at Middle River (Union Island), and Old River at Tracy Boulevard Bridge. Because the salinity at these three south Delta locations is governed largely by the San Joaquin River salinity at Vernalis, any violations of the EC objective at Vernalis could likely cause a similar violation at these south Delta locations.

The EC data presented in Figure 3-24a indicate that the 30-day average EC criterion of 700 µS/cm (April 1–August 31) was met at Vernalis during 2004. The Basin Plan amendment for salt and boron states that between 1986 and 1998, the 700 µS/cm criteria was exceeded approximately 49% of the time, and the 1,000 µS/cm was exceeded approximately 11% of the time (Central Valley Water Board 2004). However, it should be noted that the objective of 700 µS/cm at Vernalis was not established until 1995 and that the objectives for some of the other locations did not become effective until 2005. Since 1995, the releases from New Melones Reservoir have been an effective tool for meeting the Vernalis objective.

Dioxin, Furan Compounds, and PCBs

Like DDT, these chemicals are organochlorines that are extremely resilient in the environment and tend to cling to sediment. There are very few data for concentrations of these chemicals in the water column. The measurements that led to the Turning Basin being listed as impaired for these chemicals probably came from sediment or fish.

The only water column data for any of these compounds that were readily available for the Delta were the SFEI data for PCBs measured from water samples collected from the San Joaquin River near Antioch (Table 3-93). Although the criteria were exceeded 5% of the time, the average of the 19 values (84 pg/L) is below the 170 pg/L CTR criterion for 30-day average values.

Table 3-93. Summary of PCB Data Collected in the San Joaquin River near Antioch

	PCB
Earliest Date	Feb-95
Latest Date	Aug-03
Count	19
Average (pg/L)	83.61
Minimum (pg/L)	15.90
Maximum (pg/L)	209.32
Percent Exceedance	5.3

The exceedance criterion was 170 pg/L.

Dissolved Organic Carbon

DOC is not included as a contaminant in the CWA Section 303(d) list. However, it is a water quality constituent of concern in the Delta.

DOC concentration is one of the primary variables that influence the potential for formation of disinfection by-products. The most common disinfection by-products are trihalomethane (THM) compounds formed during chlorination of DOC in drinking water supplies. DOC is generally considered to be conservative (non-reactive) once introduced into the Delta channels.

THM levels in drinking water can be reduced through the use of alternatives to chlorination in treating water for human consumption (e.g., ozonation or chloromines), although other potentially harmful compounds may be formed during these other disinfection processes. Reducing DOC concentrations in raw water before chlorination with flocculation or granular activated carbon adsorption can reduce all disinfection by-product levels but may be quite expensive.

Another disinfection by-product associated with ozone treatment is bromate. Bromate is formed during ozonation in the presence of Br^- ions. Bromide is directly proportional to the chloride concentration, and so a slight increase in bromate may occur if the salinity is increased in a drinking water source.

Minimizing DOC and salinity (i.e., Br^-) concentrations in the raw water source is therefore a major water quality goal for drinking water uses.

DOC concentrations in the San Joaquin River generally range between 3.0 mg/L and 6.0 mg/L, higher than in Sacramento River inflow, which is generally the lowest measured in the Delta at around 2.0 mg/L. Sacramento River DOC concentrations sometimes exceed 3.0 mg/L, however, as the result of the presence of DOC material in surface runoff (Jones & Stokes 2005).

San Joaquin River Basin—Ahwahnee Subwatershed

General Description

The Ahwahnee Subwatershed covers approximately 412,119 acres from the headwaters of the Chowchilla and Fresno Rivers in the Sierra Nevada Mountains down to the edge of the valley floor. The subwatershed extends downstream to and includes both Hensley Lake and Eastman Lake. The Valley Floor Subwatershed is located to the west, the San Joaquin to the south and southeast, Merced to the north and northeast, and Mariposa to the northwest. (Figure 3-25.)

The climate of the San Joaquin watershed is highly variable because of the broad range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. Elevations range from 315 feet to 13,920 feet, the highest elevation in the larger San Joaquin River Basin. (USGS 2005) The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this subwatershed.

Upper Chowchilla River

In its upper watershed, the Chowchilla River has a west fork, middle fork, and east fork. The upper watershed is located in both Mariposa and Madera Counties. The east fork tributary extends the farthest into the Sierra Nevad Mountains. It originates near the Chowchilla Mountains, which are less than 7,000 feet elevation (DeLorme). The downstream end of the Upper Chowchilla River extends to the intersection of Merced County, Mariposa County, and Madera County in the northwest corner of the subwatershed about 6 miles downstream of Buchanan Dam.

Eastman Lake, formed by Buchanan Dam, is the only large reservoir in the Chowchilla River watershed. It has a capacity of 150,000 acre-feet, and its watershed area is 235 square miles. At an elevation of 600 feet, summers are warm and winters mild. Eastman Lake is used for flood control, irrigation, and recreation. The only currently operated measurement station along the Chowchilla River is the CDEC station at Eastman Lake. Releases from the lake are typically less than 200 cfs. Inflow to the lake, as demonstrated in Table 3-94 varies seasonally, with the high flows in the winter and spring and low flows in summer and fall.

Upper Fresno River

The Fresno River is located in Madera County. Hensley Lake, formed by Hidden Dam, is the only large reservoir in the Fresno River watershed. It is operated by the Corps and has a capacity of 90,000 acre-feet. The watershed area of the lake is approximately 258 square miles. Hensley Lake is used for flood control, irrigation, resource management, and recreation. The Madera Irrigation District obtains some of its water from the Fresno River. The only currently operated measurement station along the Fresno River is the CDEC station at Hensley Lake. Flow measurements, shown below in Table 3-94, indicate high flows in late winter and low flows during the summer to fall. See the Valley Floor Subwatershed section for downstream information.

Table 3-94. Eastman Lake and Hensley Lake Average Monthly Inflow

	Eastman Lake			Hensley Lake		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Jan	32	309	1,623	38	311	1,689
Feb	34	347	1,242	57	332	991
Mar	47	259	793	69	294	815
Apr	14	158	609	38	204	639
May	13	85	262	29	133	385
Jun	4	51	191	7	62	256
Jul	4	27	46	4	26	69
Aug	2	11	33	7	13	17
Sep	2	8	30	3	14	27
Oct	2	11	21	2	16	34
Nov	5	36	133	5	37	156
Dec	6	159	1,004	15	128	781

Source: CDEC website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Urban land use represents a relatively small minority of the subwatershed. The combined acreage of urban, urban landscape, commercial, and residential designations totals 17,766 acres, or 4.3% of the total acreage. Native vegetation, which consists of riparian and other vegetation, dominates the subwatershed, combining for 390,781 acres, or 94.8% of the total area. Irrigated agricultural uses are the third most abundant land use, with 1,057 acres, or 0.3%. Much of this land could be non-irrigated, as it consists mainly of pasture and semiagricultural land, and pastureland may or may not be irrigated. Miscellaneous land use types accounted for roughly 2,514 acres, or 0.6% of the total area. These uses include water surface, wetlands, and barren lands. The landscape is fairly homogenous, with most agriculture occurring near waterways. The majority of the residential land use occurs in the northern portion of the subwatershed. Table 3-95 presents the land uses in the subwatershed. (Figure 3-37.)

Table 3-95. Land Use Acreage according to DWR and FRAP Land Use Data for the Ahwahnee Subwatershed

DWR Land Use Type	Acreage	Percent Total
Agriculture		
Deciduous Fruits and Nuts	54	0.013
Pasture	644	0.156
Semiagricultural and Incidental	113	0.027
Vineyards	103	0.025
Subtotal	914	0.221
Urban		
Urban Landscape	9	0.002
Urban Residential	9,047	2.195
Commercial	29	0.007
Subtotal	9,085	2.204
Native		
Native Vegetation	221,091	53.647
Riparian Vegetation	0	0.00002
Water Surface	2,181	0.529
Subtotal	223,272	54.176
FRAP Land Use Type		
Agriculture	143	0.035
Barren/Other	13	0.003
Conifer	21,816	5.294
Hardwood	101,767	24.694
Herbaceous	29,494	7.157
Shrub	16,612	4.031
Urban	8,681	2.106
Water	312	0.076
Wetland	7	0.002
Subtotal	178,845	43.398
Total	**412,119**	**100**

Sources: DWR 2005 and CDF 2005.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Ahwhanee Subwatershed. Table 3-96 lists the beneficial uses of the Chowchilla River and Fresno River from its source to the Hidden Reservoir.

Table 3-96. Beneficial Uses by River Sub-Areas

Beneficial Uses	Fresno River	Chowchilla River
Municipal & Domestic	E	E
Irrigation	E	E
Stock Watering	E	E
Process		
Service Supply		
Power		
Rec-1	E	E
Rec-2	E	E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	E	E
Migration—Warm		
Migration—Cold		
Spawning—Warm		
Spawning—Cold		
Wildlife Habitat	E	E
Navigation		

P = Potential, E = Existing, U = Undefined.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. Fresno River and Chowchilla River are not listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003.

Water Quality

The water quality on the Upper Fresno River and Chowchilla River is excellent. As stated earlier, no 303(d) listed pollutants are associated with these rivers or their tributaries and there are no known water quality problems in this subwatershed. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this subwatershed.

San Joaquin River Basin—Mariposa Subwatershed

General Description

Mariposa Subwatershed includes 209,002 acres from the source of Bear Creek to the valley floor. The climate varies with elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The elevation ranges from 308 feet to 4,252 feet. The Mariposa Subwatershed is surrounded by the Merced River Subwatershed to the north, Ahwahnee Subwatershed to the east and southeast, and the Valley Floor Subwatershed to the west (Figure 3-26). The Mariposa Subwatershed is located within CalWater watershed boundary number 38.

Upper Bear Creek

Bear Creek originates much lower in the Sierra Nevada Mountains than the Stanislaus, Tuolumne, or Merced Rivers. It starts in Mariposa County near the town of Bear Valley, which is at 2,050 feet elevation. Just before entering Merced County, Bear Creek flows through Bear Reservoir, a small reservoir operated by the Corps (CDEC).

The USGS does not have any active gages on Bear Creek. However, CDEC has one in the subwatershed at Bear Reservoir. Flows from this gage are presented in Table 3-97, and are low, especially from April through November. During this time, very little water is released from Bear Reservoir.

Upper Owens Creek

Owens Creek flows out of the Guadalupe Mountains, a small range west of the Sierra Nevada Mountains, into Owens Reservoir, eventually reaching the valley floor. Owens Creek flow into Owens Reservoir is low year-round, but the lowest flows are from July through November. The highest flows occur from January through March (Table 3-97).

Upper Mariposa Creek

Upper Mariposa Creek flows south through the western Sierra Nevada Mountains, then heads southwest as it flows out of the mountains into Mariposa Reservoir. Tributaries to Upper Mariposa Creek include Agua Fria Creek upstream and Ganns Creek downstream. Flows into Mariposa Reservoir are intermittent with July through October having little to no flow. The highest flows occur from December through March (Table 3-97).

Table 3-97. Average Monthly Flows for Bear Creek, Owens Creek, and Mariposa Creek

	Bear Creek			Owens Creek			Mariposa Creek		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	12.06	100.77	427.30	1	26	110	9	214	815
Feb	5.80	131.05	444.41	1	29	93	6	197	725
Mar	5.00	83.68	319.00	0	27	76	7	145	422
Apr	1.57	35.38	126.75	1	16	34	3	73	181
May	0.00	12.96	32.63	0	12	22	4	49	100
Jun	0.00	6.14	17.23	0	8	21	1	24	83
Jul	0.00	3.49	12.00	0	5	15	1	4	7
Aug	0.00	2.67	12.00	0	3	14	0	0	0
Sep	0.00	2.06	9.13	0	4	15	0	0	0
Oct	0.00	2.97	13.06	0	4	14	0	2	17
Nov	0.00	8.06	26.78	0	5	19	0	14	73
Dec	2.00	56.02	322.71	0	10	50	0	83	505

Source: CDEC website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation (DWR land use type) is the primary land use feature of the subwatershed. At 97.7%, totaling 204,175 acres, this feature is spread evenly throughout the subwatershed. Urban land uses, including commercial, industrial, residential, urban, and urban landscape, are the second largest land use type with 3,970 acres, or 1.9% of total land use. Irrigated agriculture, which is made up of citrus and subtropical, grain and hay crops, pasture, semiagriculture and incidental to agriculture, and vineyards, occupies 535 acres, or 0.3% of the total acres in the subwatershed. See Table 3-98 for individual land use–type acreages. Miscellaneous land use, including water surface, vacant, and unknown (entry denied) make up the remaining 322 acres or 0.2% of total acres. (Figure 3-38.)

Table 3-98. Land Use Acreage according to DWR Land Use Data for the Mariposa Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	9	0.004
Grain and Hay	15	0.007
Pasture	256	0.122
Semiagricultural and Incidental	202	0.097
Vineyards	53	0.025
Subtotal	535	0.255
Urban		
Urban—unclassified	948	0.454
Urban Landscape	20	0.010
Urban Residential	2,797	1.338
Commercial	88	0.042
Industrial	117	0.056
Entry Denied	91	0.044
Vacant	25	0.012
Subtotal	4,086	1.956
Native		
Native Vegetation	204,175	97.690
Water Surface	206	0.099
Subtotal	204,381	97.789
Total	**209,002**	**100.000**

There is no FRAP land use data for the Mariposa Subwatershed.
Sources: DWR 2005 and CDF 2005.

Basin Plan Status

According to the Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition), there are no beneficial uses identified for waters within the Mariposa subwatershed.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. Upper Bear Creek, Mariposa Creek, and Owens Creek are not listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003.

Water Quality

The water quality on the Upper Bear, Mariposa, and Owens Creeks is excellent. As stated earlier, no 303(d) listed pollutants are associated within these creeks or their tributaries, and there are no known water quality problems in this subwatershed. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this subwatershed.

San Joaquin River Basin—Upper Mokelumne River–Upper Calaveras River Subwatershed

General Description

The Upper Mokelumne River–Upper Calaveras River Subwatershed is bordered on the north by the Sacramento-Amador and El Dorado Subwatersheds and bordered to the south by the Tuolumne River Subwatershed. To the west is the North Valley Floor Subwatershed and to the east are Alpine County and the Sierra Nevada Mountains. The subwatershed is approximately 626,776 acres (DWR 2005a) (Figure 3-27). The topography ranges broadly in this subwatershed. The minimum elevation is 203 feet, the mean elevation is 3,839 feet, and the maximum elevation is 10,371 feet (USGS 2005). The major water features in the subwatershed are the Upper Calaveras River, and the Upper Mokelumne River.

The climate of the subwatershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this subwatershed.

Upper Calaveras River/New Hogan Reservoir

The Upper Calaveras River drains east to west in Calaveras County. The Upper Calaveras River feeds New Hogan Reservoir, drains out of the base of the reservoir and meanders west by the city of Stockton. However, this analysis covers only the part of the Calaveras River that feeds New Hogan Reservoir. The outflow from the reservoir is located in the North Valley Floor Subwatershed and discussed further in that section. The storage capacity of New Hogan Reservoir is 317,100 acre-feet (DWR 2005b). Monthly average flow for the Calaveras River is included in Table 3-99 below.

Upper Mokelumne River/Pardee Reservoir

The portion of the Upper Mokelumne River that is in this subwatershed is the inflow into Pardee Reservoir. The Mokelumne River outflow from Pardee Reservoir is covered in the North Valley Floor Subwatershed. The Upper Mokelumne River makes up the border between Amador and Calaveras Counties. Above Pardee Reservoir, the Mokelumne splits into the North Fork, the Middle Fork, and the South Fork. The South Fork is unregulated and drains into the Middle Fork; however, the North Fork and Middle Fork contain diversions and dams. The main tributaries to the North Fork Mokelumne are Blue Creek to Deer Creek, and Bear Creek. The main reservoir on the North Fork Mokelumne is Salt Springs Reservoir, which has a storage capacity of 141,900 acre-feet. The tributary to the Middle Fork is Forest Creek. The Middle Fork has two reservoirs above Pardee—the Middle Fork Reservoir and the Jeff Davis Reservoir. The Middle Fork Reservoir has a storage capacity of 1,740 acre-feet, and the Jeff Davis Reservoir has a storage capacity of 1,750 acre-feet. Prior to reaching Pardee Reservoir, all three forks of the Mokelumne converge to form one inflow to the reservoir, which has a storage capacity is 197,550 acre-feet (DWR 2005b). Monthly average flow for the Mokelumne River is presented in the Table 3-99.

Table 3-99. Monthly Average Flow for the Mokelumne River and Calaveras River

	Mokelumne River near Mokelumne Hill			Calaveras below New Hogan Reservoir		
Month	Min	Mean	Max	Min	Mean	Max
Jan	308	1,400	5,659	2	257	1,223
Feb	314	1,371	2,189	1	469	1,933
Mar	617	1,579	3,338	2	520	2,843
Apr	781	1,504	2,936	1	228	1,397
May	443	2,052	4,031	61	149	234
Jun	521	2,115	5,014	67	191	251
Jul	498	1,007	2,821	67	202	271
Aug	483	639	929	77	203	265
Sep	454	592	813	3	128	197
Oct	397	579	825	3	58	122
Nov	327	608	880	2	293	1,559
Dec	451	802	2,286	2	441	1,755

Calaveras River data from 1988 to 1992. Mokelumne River data from 1995 to 2004.
Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation is the primary land use type in the Mokelumne River Subwatershed. DWR land use types native vegetation and riparian vegetation, and FRAP land use types conifer, hardwood, herbaceous, and shrub combine for 97.6% of the total land use area, or 614,450.9 acres (see Table 3-100). The second largest land use type in the subwatershed is water, which includes DWR's land use type water surface and FRAP's land use type water, and occupies 9,281 acres or 1.5% of total acres. Only 38 acres of irrigated agriculture (0.006% of total acres) exist in this watershed. Irrigated agriculture includes agriculture (FRAP land use type) and pasture (DWR land use type) though pastureland may or may not be irrigated. Urban land use including commercial, industrial, residential, and urban (DWR land use types) and urban (FRAP land use type), together combine for 3,897.8 acres or 0.6% of total acres. Barren land including vacant (DWR land use type) and barren/other (FRAP land use type) covers 1,822 acres or 0.29%. The remaining acres are wetlands, which occupy 286 acres or 0.045% of the subwatershed. (Figure 3-39.)

Table 3-100. Land Use Acreage according to DWR and FRAP Land Use Data for the Upper Mokelumne River–Upper Calaveras River Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Pasture	1	0.0002
Subtotal	1	0.0002
Urban		
Urban—unclassified	99	0.016
Urban Residential	1,418	0.225
Commercial	93	0.015
Industrial	25	0.004
Vacant	28	0.004
Subtotal	1,663	0.264
Native		
Native Vegetation	200,038	31.763
Riparian Vegetation	401	0.064
Water Surface	3,696	0.587
Subtotal	204,135	32.414
FRAP Land Use Type		
Agriculture	37	0.006
Barren/Other	1,794	0.285
Conifer	213,165	33.848
Hardwood	91,531	14.534
Herbaceous	54,051	8.583
Shrub	55,265	8.775
Urban	2,263	0.359
Water	5,585	0.887
Wetland	286	0.045
Subtotal	423,977	67.322
Total	**629,776**	**100.000**

Source: DWR 2005a, CDF 2005

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Upper Mokelumne River–Upper Calaveras River Subwatershed. Table 3-101 lists the beneficial uses of the Mokelumne River from its source to Pardee Reservoir and the Calaveras River from its source to New Hogan Reservoir.

Table 3-101. Beneficial Uses by River Sub-Areas

Beneficial Use	Upper Mokelumne River	Upper Calaveras River
Municipal & Domestic	E	
Irrigation		
Stock Watering		
Process		
Service Supply		
Power	E	
Rec-1 (Contact)	E	E
Rec-2 (Noncontact)	E	E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	E	E
Migration—Warm	E	E
Migration—Cold		
Spawning—Warm	E	E
Spawning—Cold	E	E
Wildlife Habitat	E	E
Navigation		

P = Potential, E = Existing, U = Undefined.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Upper Mokelumne and Upper Calaveras are not listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. However, both lower sections are listed as impaired. For a detailed analysis of the lower portions of these rivers, refer to the North Valley Floor Subwatershed section.

Water Quality

The water quality on the Upper Mokelumne, and Upper Calaveras River is excellent. As stated earlier, no 303(d) listed pollutants are associated with the Upper Mokelumne River and Upper Calaveras River. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this subwatershed. There are no known water quality problems associated with these rivers.

San Joaquin River Basin—Merced River Subwatershed

General Description

Upper Merced River

The Merced River drains an approximately 1,276–square mile watershed on the western slope of the Sierra Nevada Mountains in the southern portion of California's Central Valley. Elevations in the basin range from 13,000 feet in Yosemite National Park to approximately 338 feet near Merced Falls (USGS 2005). The upstream watershed for the Merced River corresponds to Calwater watershed number 37. The Upper Merced River Subwatershed is bordered by the Tuolumne River Subwatershed to the North, the Mariposa, Fresno River, and San Joaquin River Subwatersheds to the south, the Valley Floor to the west, and the Tuolumne and San Joaquin River Subwatersheds to the east (Figure 3-28).

Principal tributaries of the Merced River include the Merced Peak, Lyell, Triple Peak, and Red Peak Forks, as well as Echo, Sunrise, Illilouette, Tenaya, Yosemite, Bridalveil, Cascade, Grouse, Avalanche, Indian, and Crane Creeks. The river descends 8,000 feet from its headwaters through glacially carved canyons over 24 miles. When it enters Yosemite Valley, the river flows in a shallow channel approximately 100–300 feet wide in most places. From the valley the river, at a gradient of 70 ft/mile, winds through narrow, steep-sided Merced River gorge. The South Fork flows westward from its headwaters at about 10,500 feet to 3,500 feet at its confluence with Merced River downstream from El Portal. Tributaries of the South Fork include Chilnualna Creek, Big Creek, Alder Creek, and Bishop Creek. (NPS 2005.) In October of 1968 the Wild and Scenic Rivers Act was passed to protect designated rivers from degradation. The Merced River is listed as a wild and scenic river under the Wild and Scenic River Act. The designated area is from its source (including Red Peak Fork, Merced Peak Fork, Triple Peak Fork, and Lyle Fork) in Yosemite National Park to a point 300 feet upstream of the confluence with Bear Creek. The South Fork from its source in Yosemite National Park to the confluence with the main stem. The classification is broken up into 71 miles of Wild, 16 miles of scenic, 35.5 miles of recreational for a total of 122.5 miles.

Exchequer Dam forms Lake McClure, the largest reservoir on the Merced River, with a capacity of 1,046,000 acre-feet and a watershed of approximately 1,037 square miles. Downstream of Lake McClure, McSwain Dam forms Lake McSwain. The Merced River from Lake McSwain upstream to its headwaters, approximately 55 river miles, will be discussed in this section. Table 3-102 contains minimum, mean and maximum flows recorded at the Merced River inflow into McClure Reservoir from 1995–2004.

Table 3-102. Average Monthly Flows

	Minimum	Mean	Maximum
Jan	247.7	1,962.3	8,106.2
Feb	542.2	1,686.3	4,258.1
Mar	928.9	1,907.8	4,393.3
Apr	1,304.8	2,517.3	3,489.7
May	2,178.3	4,054.3	6,301.3
Jun	500.1	3,172.5	8,030.6
Jul	110.3	900.2	4,538.9
Aug	3.5	226.1	1,146.9
Sep	0.4	88.2	465.5
Oct	6.9	85.6	287.3
Nov	40.4	288.5	944.9
Dec	56.7	745.2	3,740.4

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

The primary land use in this subwatershed is native vegetation. Occupying 655,621 acres, or 93.2%, this broad land use type includes native vegetation and riparian vegetation DWR land use types, and conifer, hardwood, herbaceous, and shrub FRAP land use types. See Table 3-103 for individual land use type acreages. Urban land uses, including commercial, industrial, residential, urban, and urban landscape, occupy 9,289 acres, which is only 1.3% of total land use in the subwatershed. Very little irrigated agriculture exists in the subwatershed. Deciduous fruits and nuts, pasture (pasture land may or may not be irrigated), semiagricultural and incidental to agriculture, and vineyards combine for 2,619 acres, or 0.4% of total land use acres. Miscellaneous land uses (DWR land use type water surface, FRAP land use types barren/other, water, and wetland) make up the remaining 35,757.7 acres, or 5.1% of total acreage. (Figure 3-40.)

Table 3-103. Land Use Acreage according to DWR and FRAP Land Use Data for the Merced River Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	30	0.004
Pasture	2,471	0.351
Semiagricultural and Incidental	111	0.016
Vineyards	7	0.001
Subtotal	2,619	0.372
Urban		
Urban—unclassified	250	0.036
Urban Landscape	392	0.056
Urban Residential	8,417	1.197
Commercial	194	0.028
Industrial	36	0.005
Subtotal	9,289	1.322
Native		
Native Vegetation	583,543	82.974
Riparian Vegetation	344	0.049
Water Surface	6,254	0.889
Subtotal	590,141	83.912
FRAP Land Use Type		
Barren/Other	26,913	3.827
Conifer	68,026	9.673
Hardwood	877	0.125
Herbaceous	22	0.003
Shrub	2,809	0.399
Water	1,103	0.157
Wetland	1,488	0.212
Subtotal	101,238	14.396
Total	**703,287**	**100**

Sources: DWR 2005 and CDF 2005.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Merced River Subwatershed. Table 3-104 lists the beneficial uses of the Merced River upstream of McSwain Dam.

Table 3-104. Beneficial Uses by River Sub-Areas as Depicted in EH Example

Beneficial Uses	Merced River
Municipal & Domestic	P
Irrigation	E
Stock Watering	
Process	
Service Supply	
Power	E
Rec-1 (Contact)	E
Rec-2 (Non-Contact)	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing, U = Undefined.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Merced River above Merced Falls is not listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. However, it is important to note that the Merced River downstream of Lake McSwain Reservoir is impaired for chlorpyrifos, diazinon, and group A pesticides. For more information on these impairments see the San Joaquin Valley Floor Subwatershed.

Water Quality

The water quality on the Upper Merced River is excellent. As stated earlier, no 303(d) listed pollutants are associated with the Merced River or its tributaries. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this subwatershed. However, it is important to note that downstream Merced River water quality is impaired for three pollutants. See the San Joaquin Valley Floor Subwatershed for more information.

San Joaquin River Basin—North Valley Floor

General Description

The North Valley Floor Subwatershed covers approximately 571,000 acres from the Sierra Nevada foothills to the eastern edge of the Delta. The North Valley Floor subwatershed lies mostly within San Joaquin County although the eastern edge extends (from north to south) into Amador, Calaveras, and Stanislaus Counties. The elevation in this subwatershed ranges from –3 to 2,582 feet. It is a combination of CalWater regions 31 (North Valley Floor) and 70 (Gopher Ridge). The San Joaquin County and Delta Water Quality Coalition covers the portion of the North Valley Floor Subwatershed that lies within San Joaquin County. (Figure 3-29.)

The climate of the North Valley Floor Subwatershed is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. The weather conditions are somewhat more moderate than the rest of the Central Valley because of the effect of ocean air on the weather in the Delta. The winter snowpack in the Sierra Nevada Mountains, which accumulates above 5,000 feet elevation (outside of this subwatershed), supplies much of the water in the basin. There are, however, some small drainages that do not extend into the mountains.

The discussion below provides more detail about the waterways in the North Valley Floor Subwatershed that are the larger ones in the subwatershed and/or that have water quality issues.

Mokelumne River

The Mokelumne River is the largest River in the North Valley Floor Subwatershed. The lower Mokelumne River extends 28 miles from Camanche Dam to the Delta. The portion of the river in the North Valley Floor Subwatershed includes Camanche Reservoir and extends close to the Delta, approximately 7 miles upstream of the confluence with the Cosumnes River (Figure 3-29). Camanche Reservoir is the largest reservoir in the Mokelumne River watershed with a capacity of 430,800 acre-feet. The East Bay Municipal Utility District withdraws water from Pardee Reservoir, which is upstream of Camanche Reservoir.

Monthly average releases from Camanche Reservoir vary between about 150 cfs and 5,000 cfs (Table 3-105). Average releases are approximately 1,000 cfs during the winter and spring and taper down to approximately 300 cfs during the fall. Flows downstream at Woodbridge (just northwest of the City of Lodi) are considerably lower, partly because of the diversions to the Woodbridge Canal at Lodi Lake.

Table 3-105. Mokelumne River Flows (cfs) Measured from 1995 through 2004

	Below Camanche			At Woodbridge		
Month	Minimum	Average	Maximum	Minimum	Average	Maximum
Jan	242	861	4,978	194	906	4,746
Feb	239	1,552	4,315	183	1,466	4,285
Mar	258	1,372	2,725	181	1,019	2,262
Apr	283	978	2,923	173	547	1,490
May	423	1,075	3,155	166	572	1,660
Jun	378	1,242	3,847	39	619	2,085
Jul	321	1,011	2,932	41	518	2,561
Aug	258	674	1,770	34	298	1,462
Sep	220	436	1,447	30	86	149
Oct	243	350	639	96	141	199
Nov	230	317	372	195	280	320
Dec	235	546	1,991	199	517	1,861

Both sites are missing data for October–December 2004. Woodbridge site also is missing January 1995–September 1996.

Source: USGS website.

Calaveras River

New Hogan Reservoir, which is upstream of the North Valley Floor Subwatershed and has a capacity of 317,100 acre-feet, is the largest reservoir in the Calaveras River watershed and is operated by the Corps. The Calaveras River runs east to west through the middle of the North Valley Floor Subwatershed. The portion of the Calaveras River in the North Valley Floor Subwatershed extends from Jenny Lind Road (about 7 miles downstream of New Hogan Reservoir) to the Delta near Stockton. The monthly average releases from New Hogan Reservoir vary from about 10 to 3,100 cfs, with average flows from spring through fall staying at approximately 100–200 cfs. (See Table 3-106.)

Table 3-106. Calculated Outflow from New Hogan Reservoir (cfs) Measured from 1995 through 2004

Month	Minimum	Mean	Maximum
Jan	29	468	3,105
Feb	22	744	3,093
Mar	13	213	669
Apr	59	181	538
May	130	214	517
Jun	175	221	347
Jul	181	235	334
Aug	172	219	337
Sep	133	179	308
Oct	44	95	255
Nov	24	94	402
Dec	26	189	1,278

Data were not continuous.
Source: CDEC station NHG.

Mormon and Walker Sloughs

Both Mormon and Walker Sloughs are small tributaries to the Delta. They have similar water quality problems that are associated with their proximity to the Stockton urban area.

Mormon Slough originates as a diversion from the Calaveras River at Bellota. It passes through Stockton and connects to the southern edge of the Turning Basin. Two sections of Mormon Slough have water quality issues. Commerce Street is located near the boundary between the Delta-Carbona Subwatershed and the North Valley Floor Subwatershed and it is the dividing line for the two impaired sections of Mormon Slough. As a result, the downstream portion, from Commerce Street to the Turning Basin, is included in the Delta-Carbona Subwatershed, whereas the upstream portion is included in the North Valley Floor Subwatershed.

Walker Slough is predominantly in the North Valley Floor Subwatershed although it extends into the Delta-Carbona Subwatershed. Walker Slough is a small section of channel about 2 miles long that is connected to Duck Creek at its upstream end and French Camp Slough at its downstream end. It is located south of Mormon Slough near the southern edge of Stockton.

Tributaries to Little Johns Creek

Little Johns Creek is a small drainage that connects to French Camp Slough and the Delta. Little Johns Creek is not considered to have significant water quality problems, but some of its tributaries have water quality issues that are associated with their proximity to dairies. These small tributaries are:

- **Lone Tree Creek**—Lone Tree Creek runs along the southern edge of the North Valley Floor Subwatershed, with some small sections falling within the San Joaquin Valley Floor Subwatershed. Lone Tree Creek is a direct tributary to Little Johns Creek
- **Temple Creek**—Temple Creek is north of Lone Tree Creek and is a small tributary to Lone Tree Creek.
- **Avena Drain—**Avena Drain is also a tributary to Lone Tree Creek and is located between Lone Tree Creek and Temple Creek. Its main source of inflow is agricultural drainage and storm runoff.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photographs and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation is the primary land use in the North Valley Floor Subwatershed. Native vegetation, including DWR land use types native vegetation and riparian vegetation and FRAP land use types conifer, hardwood, herbaceous, and shrub, covers 283,178.5 acres, or 49.6% of total acres. Most of the native vegetation is located in the eastern portion of the subwatershed (Figure 3-41).

Irrigated agriculture is the second largest land use type in the subwatershed with 230,185.5 acres or 40.3% of total acres. Irrigated agriculture includes DWR land use types citrus and subtropical, deciduous fruits and nuts, field crops, grain and hay crops, pasture (which may or may not be irrigated), rice, semiagriculture and incidental to agriculture, truck, nursery, and berry crops, and vineyards, and FRAP land use type agriculture.

There are 36,338.8 acres of urban land use (6.46%), which includes DWR land use types commercial, industrial, residential, urban, and urban landscape and FRAP land use type urban. Barren land, made up of DWR land use types barren and wasteland, idle, and vacant, and FRAP land use type Barren/Other, occupies

10,447 acres (1.8%). The remaining 10,848 acres (1.9%) of the North Valley Floor Subwatershed are water (DWR water surface and FRAP water). Acreages for individual land use are available in Table 3-107.

Table 3-107. Land Use Acreage according to DWR and FRAP Land Use Data for the North Valley Floor Subwatershed

DWR Land Use Types	Acres	Percent Total
Agriculture		
Citrus and Subtropical	58	0.010
Deciduous Fruits and Nuts	51,692	9.053
Field Crops	22,371	3.918
Grain and Hay	31,120	5.450
Idle	6,233	1.092
Pasture	32,557	5.702
Rice	2,963	0.519
Semiagricultural and Incidental	4,466	0.782
Truck, Nursery, and Berry Crops	22,301	3.906
Vineyards	61,895	10.840
Subtotal	235,656	41.272
Urban		
Urban—unclassified	27,258	4.774
Urban Landscape	1,689	0.296
Urban Residential	3,559	0.623
Commercial	734	0.129
Industrial	2,825	0.495
Vacant	3,922	0.687
Subtotal	39,987	7.004
Native		
Native Vegetation	167,613	29.354
Barren and Wasteland	11	0.002
Riparian Vegetation	966	0.170
Water Surface	7,055	1.236
Subtotal	175,645	30.762
FRAP Land Use Types		
Agriculture	762	0.133
Barren/Other	280	0.049
Conifer	7,975	1.397
Hardwood	34,460	6.035
Herbaceous	70,008	12.261
Shrub	2,157	0.378
Urban	274	0.048
Water	3,793	0.664
Subtotal	119,709	20.965
Total	**570,998**	**100.000**

Sources: DWR 2005; CDF 2005.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the North Valley Floor Subwatershed. Table 3-108 lists the beneficial uses of Camanche Reservoir, the lower Mokelumne River (from Camanche Dam to the Delta), and the Calaveras River from New Hogan Reservoir to the Delta.

Table 3-108. Beneficial Uses by North Valley Floor Subwatershed Sub-Areas

Beneficial Uses	Camanche Reservoir	Lower Mokelumne River	Lower Calaveras River
Municipal & Domestic	E		E
Irrigation	E	E	E
Stock Watering	E	E	E
Process			P
Service Supply			P
Power			
Rec-1 (Contact)	E	E	E
Rec-2 (Non-contact)	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold	E	E	E
Migration—Warm	E	E	E
Migration—Cold		E	E
Spawning—Warm	E	E	E
Spawning—Cold	E	E	E
Wildlife Habitat	E	E	E
Navigation			

P = Potential, E = Existing, U = Undefined.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list.

In the North Valley Floor Subwatershed, seven water bodies are included on the 2002 303(d) list that was last updated by the EPA in July 2003 as having impaired water quality (Table 3-109). Camanche Reservoir and the lower Mokelumne River are listed as impaired for copper and zinc, with resource extraction (mining) being the probable source of the problem. Dairies are the probable source of bad water quality in Avena Drain (ammonia and EC), Lone Tree Creek (ammonia, biochemical oxygen demand [BOD], and EC), and Temple Creek (ammonia and EC). Walker Slough and Mormon Slough are listed as impaired for pathogens. The elevated pathogen levels are likely derived from the proximity of these sloughs to the Stockton urban area, with urban runoff, storm sewers, and recreational and tourism activities being listed as potential sources.

Table 3-109. Impaired Waterways in the North Valley Floor Subwatershed

Watershed/Subwatershed	Pollutant	TMDL Priority	Approximate Size Affected
Camanche Reservoir	Copper	Low	7,389 acres
	Zinc	Low	
Mokelumne River	Copper	Low	29 miles
	Zinc	Low	
Avena Drain	Ammonia	Low	6.4 miles
	Pathogens	Low	
Lone Tree Creek	Ammonia	Low	15 miles
	BOD	Low	
	EC	Low	
Temple Creek	Ammonia	Low	10 miles
	EC	Low	
Mormon Slough (Stockton Diverting Canal to Commerce Street)	Pathogens	Medium	5.2 miles
Walker Slough	Pathogens	Medium	2.3 miles

Source: CWA Section 303(d).

Table 3-110 presents some of the federal and state criteria for some of the water quality constituents of concern in the North Valley Floor Subwatershed.

Table 3-110. Water Quality Criteria

	Aquatic Life Criteria (µg/L)		Human Health Criteria (µg/L)		
Compound	EPA—Chronic	EPA—Acute	EPA—SNARL	CDHS Action Level	CTR
Copper	2.3[a] (dissolved)	2.9[a] (dissolved)	NA	NA	1,300 (total)
Zinc	30[a]	30[a]	2,000	NA	NA
Aluminum	87	750	NA	NA	NA

[a] The criteria are dependent on hardness and these values assume a hardness of 20 mg/L.

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. CTR values are the 30-day average values for drinking water for the California Toxics Rule.

Source: Central Valley Water Board 2005.

Water quality objectives for the other constituents of concern (EC, BOD, pathogens, and ammonia) are discussed below:

- **EC**—The water bodies in the North Valley Floor Subwatershed that are listed as impaired for EC are tributaries to the Delta. As a result, the Basin Plan EC objectives for the Delta are relevant. The Delta objectives depend on location, time of year, and water year type. Criteria for the western and interior portions of the Delta, which receive some influence from the freshwater Sacramento River, start as low as 450 µmhos but go up for drier years. Criteria in the south Delta and at the export pumps at Tracy and Banks pumping plants range between 700 and 1,000 µmhos. This area is more influenced by the relatively salty San Joaquin River.
- **BOD**—BOD has the potential to reduce DO concentrations to the point where fish may die. Water bodies with high BOD can have adequate DO as long as there is sufficient aeration from the surface. As part of a water quality program plan for the improvement of DO conditions in the Delta, one goal is to maintain BOD levels in the tributaries near Stockton below 30 mg/L (CalWater 2005 web page).
- **Bacteria (pathogens)**—The Basin Plan currently has two objectives for fecal coliform bacteria. The geometric mean concentration should not exceed 200 per 100 ml, and the 90th percentile should not exceed 400 per 100 ml. For this analysis, data should exist for at least five measurements in a 30-day period. In 2002, the Central Valley Water Board adopted a modification to these objectives. This modification is awaiting approval from other agencies (Central Valley Water Board 2002a). The modified objectives replace fecal coliform measurements with *E. coli* measurements. The geometric mean of *E. coli* concentrations should not exceed 126 per 100 ml, and no sample should exceed 235 per 100 ml. The 126 per 100 ml objective is the same as listed in EPA guidelines, and the 235 per 100 ml objective is in guidelines from the CDHS (Central Valley Water Board 2001).
- **Ammonia**—The ammonia criteria for the protection of freshwater aquatic life depend on pH, temperature, and whether juvenile fish are present. The ammonia criteria values range from 179 to 10,800 µg/L (Central Valley Water Board 2005). If juvenile fish are present, temperature is 20°C, and pH is 7.0, then the criterion is 4.15 mg/L. Freshwater aquatic life is more vulnerable to undissociated (non-ionized) ammonia, and levels of undissociated ammonia should not exceed the DFG criterion of 0.02 mg/L (Central Valley Water Board 2001).

Water Quality

Mines, agriculture, dairies, and urban areas are the primary sources of water quality problems in the North Valley Floor Subwatershed.

In 2004, the San Joaquin County & Delta Water Quality Coalition began monitoring water quality (Johnson 2005). Five sites were in the Delta-Carbona

Subwatershed. Future monitoring will cover more sites providing useful information.

Most of the water quality data discussed below was compiled from various sources by the Central Valley Water Board.

Camanche Reservoir and Lower Mokelumne River

Water quality impairments in Camanche Reservoir and the Mokelumne River are associated with resource extraction, particularly copper and gold mining upstream of Camanche Dam. Penn Mine, a copper extraction mine next to Camanche Reservoir, has contributed to water quality problems. However, between 1978 and 1999 several abatement projects were undertaken to reduce the metal contamination from this mine.

Camanche Reservoir and the lower Mokelumne River are shown on the 303(d) list as being impaired for copper and zinc. The Central Valley Water Board has also recommended that Camanche Reservoir and the lower Mokelumne River be listed as impaired for aluminum (Central Valley Water Board 2001).

Copper and Zinc—Copper and zinc concentrations have been measured in the lower Mokelumne River since 1958. The measurements indicate that concentrations tend to be higher during the rainy season. The measurements also indicate that the concentrations decreased in response to the remedial actions taken at the Penn Mine site. The last abatement project was finished toward the end of 1999.

Recent measurements indicate that copper levels are still somewhat elevated. Of 44 samples collected downstream of Camanche Dam from September 1999 through June 2001, 11% of the results exceeded the EPA acute criterion of 2.9 µg/L for aquatic life (Central Valley Water Board 2001). The most recent available zinc data are from samples collected between 1989 and 1992 downstream of Camanche Dam. Of the 242 samples, 8% exceeded the 30 µg/L EPA acute criterion for aquatic life (Central Valley Water Board 2001). Note that these criteria assume a hardness value of 20 mg/L, which is representative for the lower Mokelumne River.

Aluminum—Of 260 samples collected from Camanche Reservoir between 1993 and 1996, 7% had aluminum concentrations that exceeded the EPA acute criterion of 750 µg/L for aquatic life. Twelve samples were collected during 1999–2000 and none exceeded the 750-µg/L criterion, but some exceeded the EPA chronic criterion of 87 µg/L. Between 1988 and 1992, 257 water samples were collected downstream of Camanche Dam and analyzed for aluminum. Fourteen percent of the concentrations exceeded 750 µg/L.

Calaveras River

No data were found demonstrating water quality problems in the Calaveras River.

Mormon and Walker Sloughs

Mormon and Walker Sloughs are included in the 303(d) list for having elevated levels of pathogens. The presence of pathogens in these waterways is likely caused by their proximity to the Stockton urban area.

These waterways were listed as impaired for pathogens based on *E. coli* measurements collected during 2000–2001. These measurements are described in Appendix A of the report on recommended changes to the CWA Section 303(d) list (Central Valley Water Board 2001), and they are summarized below in Table 3-111. At all locations, the proposed criterion of 126 per 100 ml for the geometric mean *E. coli* concentration was exceeded.

Table 3-111. Concentrations of *E. Coli*

Waterway	Location	Geometric Mean of *E. coli* Measurements per 100 ml
Mormon Slough	1 mile upstream of Deep Water Ship Channel	1,272
Walker Slough	Downstream Site	506
	Upstream Site	1,182

Tributaries to Little Johns Creek

There are many dairies in the vicinity of Avena Drain, Temple Creek, and Lone Tree Creek. Wastewater from these dairies is the likely source of elevated levels of EC, BOD, ammonia, and pathogens in these creeks.

There is more information available for Avena Drain than for the other creeks. During 10 years of sampling, undissociated ammonia levels in Avena Drain or its source water were between 0.66 and 3.03 mg/L, with an average of 1.93 mg/L, well above the DFG criterion of 0.02 mg/L for aquatic life (Central Valley Water Board 2002b).

Of 14 water samples collected from Avena Drain in 2000 and 2001, 13 samples had E. coli concentrations greater than the single sample criterion of 235 per 100 ml. Geometric mean values for three sites were: 7,743; 950; and 6,239 per 100 ml (Central Valley Water Board 2001).

High levels of BOD have been detected in Little Johns Creek, Lone Tree Creek, and Temple Creek, with concentrations frequently exceeding the 30-mg/L criterion. Temple Creek had the highest concentration, 126 mg/L (CalWater 2005).

Lone Tree Creek at Jack Tone Road is a sample site for the San Joaquin County & Delta Water Quality Coalition. Sediment toxicity was found at this site in 2004.

San Joaquin River Basin—Stanislaus River Subwatershed

General Description

Upper Stanislaus River

The Stanislaus River forms the northern boundary of Stanislaus and Tuolumne Counties and flows near the cities of Ripon, Riverbank, and Oakdale. It drains an area of about 997 square miles from its source to Knights Ferry. The climate of the Stanislaus River Subwatershed is highly variable because of the wide range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this subwatershed. Elevations range from 180 feet to 11,365 feet (USGS 2005). The upper watershed occupies Calwater watershed unit 34. (Figure 3-30.)

The largest reservoir in the Stanislaus River watershed is New Melones, with a capacity of 2,420,000 acre-feet. Reclamation operates New Melones Reservoir on the Stanislaus River, east of Oakdale, in part with the goal to meet water quality salinity standards in the San Joaquin River at Vernalis, downstream of where the Stanislaus and Tuolumne rivers flow into the San Joaquin River. For full minimum, mean, and maximum monthly average flow see Table 3-112.

New Melones is fed by the upper Stanislaus River watershed (approximately 900 square miles). Some of the larger water storage facilities in the upper watershed are New Spicer Meadow Reservoir, which is along Highland Creek, which feeds the North Fork Stanislaus River; Beardsley Lake and Donnell Lake along the Middle Fork Stanislaus River; and Pinecrest Lake along the South Fork Stanislaus River. The highest mean flows into New Melones occur in May and June, at 3,109 cfs and 2,836 cfs, respectively. The lowest mean inflow occurs in November at 652 cfs. For full minimum, mean, and maximum monthly average flow see Table 3-112.

Table 3-112. Monthly Average Flows

	Min	Mean	Max
Jan	471	2,310	9,759
Feb	624	2,140	3,606
Mar	921	2,400	5,084
Apr	1,305	2,309	3,968
May	1,109	3,109	6,335
Jun	588	2,836	6,950
Jul	482	1,549	4,406
Aug	592	968	1,471
Sep	478	927	1,255
Oct	396	834	1,228
Nov	448	681	1,053
Dec	640	1,210	3,659

Source: CDEC website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report because DWR and FRAP were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation is the primary land use in the Stanislaus River Subwatershed. DWR land use types native vegetation and riparian vegetation combine with FRAP land use types conifer, hardwood, herbaceous, and shrub for a total of 611,335.5 acres, or 95.8% of total acres. Water is the second largest land use type with 18,342 acres or 2.9% and includes DWR land use type water surface and FRAP land use type water. Urban land uses, including commercial, industrial, residential, and urban DWR land use types and urban FRAP land use type, combine for 1% (6,262.6 acres) of total acres. Barren land makes up 0.205% of total acres, with 1,309 acres of DWR’s vacant land use type and FRAP’s barren/other land use type combined. Very little irrigated agriculture is located in this watershed. Irrigated agriculture includes deciduous fruits and nuts, pasture (which may or may not be irrigated), semiagriculture and incidental to agriculture, truck, nursery and berry, and vineyard (DWR land use types) and agriculture (FRAP land use type). Combined, these land uses occupy 696.0 acres, or 0.1% of total acres. The remaining 131 acres are FRAP wetland, occupying 0.021% of total acres. See Table 3-113 for acreages by individual land use type. (Figure 3-42.)

Table 3-113. Land Use Acreage according to DWR and FRAP Land Use Data for the Stanislaus River Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	8	0.001
Pasture	410	0.064
Semiagricultural and Incidental	117	0.018
Truck, Nursery, and Berry Crops	0.268	0.00004
Vineyards	5	0.001
Subtotal	540	0.084
Urban		
Urban—unclassified	703	0.110
Residential	2,553	0.400
Commercial	512	0.080
Industrial	299	0.047
Vacant	146	0.023
Subtotal	4,213	0.660
Native		
Native Vegetation	501,410	78.582
Riparian Vegetation	230	0.036
Water Surface	11,701	1.834
Subtotal	513,341	80.452
FRAP Land Use Type		
Agriculture	156	0.024
Barren/Other	1,163	0.182
Conifer	39,831	6.242
Hardwood	33,489	5.248
Herbaceous	20,375	3.193
Shrub	16,001	2.508
Urban	2,195	0.344
Water	6,641	1.041
Wetland	131	0.021
Subtotal	119,982	18.803
Total	**638,076**	**100**

Sources: DWR 2005 and CDF 2005.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) described beneficial uses for waters within the Stanislaus River Subwatershed. Table 3-114 lists the beneficial uses of the Stanislaus River from the source to Tulloch Reservoir.

Table 3-114. Beneficial Uses by River Sub-Areas

Beneficial Uses	Upper Stanislaus River
Municipal & Domestic	E,P
Irrigation	E
Stock Watering	E
Process	
Service Supply	
Power	E
Rec-1 (Contact)	E
Rec-2 (Noncontact)	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing, U = Undefined.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Upper Stanislaus River is not listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. However, it is important to note that the Stanislaus River downstream is impaired for diazinon, group A pesticides, mercury, and unknown toxicity. For more information on these impairments see the San Joaquin Valley Floor Subwatershed description.

Water Quality

The water quality on the Upper Stanislaus River is excellent. As stated earlier, no 303(d) listed pollutants are associated with the Upper Stanislaus River or its tributaries. This is likely due to the dominance of native vegetation and low occurrence of urban, industrial, irrigated agriculture, or other developed land uses in this subwatershed. However, it is important to note that downstream the Stanislaus River water quality is much lower and the river is impaired for four different pollutants. See the San Joaquin Valley Floor Subwatershed description for further information.

San Joaquin River Basin—Tuolumne River Subwatershed

General Description

The upper Tuolumne River subwatershed covers approximately 1,034,000 acres from the headwaters of the Tuolumne River high in the Sierra Nevada Mountains down to the San Joaquin valley floor (see Figure 3-31). The subwatershed extends as far downstream as the Tuolumne River at La Grange, which is approximately 5 miles downstream of Don Pedro Reservoir. The Tuolumne River watershed lies almost entirely within Tuolumne County with its western edge following the Stanislaus County line, its southern edge following the Mariposa County line, and its eastern edge following the Mono County line. The elevation in this subwatershed ranges from 177 to 13,031 feet. It corresponds to CalWater region 36.

The climate of the Tuolumne River watershed is highly variable because of the large range in elevation. At the lower elevations, the climate is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F, and winter temperatures are only occasionally below freezing. Conditions are cooler and there is more precipitation at the higher elevations. The winter snowpack, which accumulates above 5,000 feet elevation, supplies much of the water in this subwatershed.

Upper Tuolumne River

The largest reservoir in the Tuolumne River watershed is Don Pedro Reservoir, with a capacity of 2,030,000 acre-feet and a watershed of approximately 1,500 square miles. It provides both flood control and water supply for the Modesto area and is jointly operated by the MID and the TID.

The Tuolumne River originates in Yosemite National Park in Tuolumne Meadows at the confluence of the Dana Fork and the Lyell Fork. Downstream of Tuolumne Meadows, the water flows into Hetch Hetchy Reservoir, owned by the City and County of San Francisco. Hetch Hetchy is the second largest reservoir on the Tuolumne River with a capacity of 360,400 acre-feet. Both Hetch Hetchy and Lake Eleanor, a smaller reservoir with a storage capacity of 26,110 acre-feet, are located in Yosemite National Park. In October of 1968 the Wild and Scenic Rivers Act was passed to protect designated rivers from degradation. The Tuolumne River is listed as a wild and scenic river under the Wild and Scenic River Act. The designated area is from its source to Don Pedro Reservoir. The designations are broken up into 47 miles of Wild, 23 miles of Scenic, and 13 miles of Recreational.

Major tributaries to the Tuolumne River upstream of Don Pedro Reservoir include the North, South, and Middle Forks of the Tuolumne River, Cherry

Creek, and the Clavey River. Cherry Lake is another large reservoir in the Tuolumne River watershed. It has a capacity of 274,300 acre-feet and is located on Cherry Creek. Some water from the South Fork of the Stanislaus River can enter the Tuolumne River watershed via the Tuolumne Canal.

The Clavey River is one of the longest undammed rivers in the Sierra Nevada Mountains. The Clavey flows from its source in alpine lakes in the Emigrant Wilderness (north of Yosemite National Park) for 47 miles to its confluence with the Tuolumne River.

Table 3-115 shows the average inflow into Don Pedro Reservoir. The values presented are the minimum, mean, and maximum of the monthly average values for data measured between 1995 and 2004. These flows are influenced primarily by rainfall, snowmelt, and the operations at the upstream reservoirs. The highest monthly average flows (up to 14,315 cfs) occur in the winter and can extend through the spring snowmelt. The lowest monthly average flows (as low as 152 cfs) occur in the late summer and fall.

Table 3-115. Calculated Inflow to Don Pedro Reservoir (cfs) Measured from 1995 through 2004

Month	Minimum	Mean	Maximum
Jan	707	4,444	14,315
Feb	1,512	4,255	7,601
Mar	1,646	4,345	6,477
Apr	2,109	4,061	5,696
May	2,371	5,476	10,366
Jun	315	5,164	10,264
Jul	292	3,092	9,880
Aug	250	1,006	2,368
Sep	152	580	1,010
Oct	292	498	848
Nov	194	575	1,266
Dec	225	1,510	6,517

Data were not continuous
Source: CDEC station DNP

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. DWR and FRAP were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation is the primary land use in the Tuolumne River Subwatershed. DWR land use types native vegetation and riparian vegetation combine for 990,718.5 acres or 95.8% of total acres (Figure 3-43). Water, according to DWR's surface water land use type data, is the second largest land use type with 22,026.5 acres or 2.13% of total acres. Very little urban and irrigated agriculture exists in the Tuolumne River Subwatershed. Urban land uses, including DWR landscape types commercial, industrial, residential, urban, and urban landscape, combine for 1.9% of total acres or 19,460.3 acres. Irrigated agriculture, made up of DWR land use types deciduous fruits and nuts, pasture that may or may not be irrigated, semiagriculture and incidental to agriculture, and truck, nursery, and berry crops, occupies 1,278.6 acres or 0.1% of total land use. Barren land, including barren and wasteland, and vacant DWR land use types, cover the remaining 476.75 acres or 0.046% of total land use. Individual land use type acreages are presented below in Table 3-116.

Table 3-116. Land Use Acreage according to DWR Land Use Data for the Tuolumne River Subwatershed

Land Use	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	253	0.024
Pasture	738	0.071
Truck, Nursery, and Berry Crops	25	0.002
Semiagricultural and Incidental	262	0.025
Subtotal	1,278	0.122
Urban		
Urban—unclassified	3148	0.304
Urban Landscape	488	0.047
Urban Residential	13,835	1.338
Commercial	1,092	0.106
Industrial	897	0.087
Vacant	463	0.045
Subtotal	19,923	1.927
Native		
Native Vegetation	990,086	95.757
Barren and Wasteland	14	0.001
Riparian Vegetation	633	0.061
Water Surface	22,026	2.130
Subtotal	1,012,759	97.949
Total	**1,033,961**	**100.000**

There is no FRAP land use data for the Tuolumne River Subwatershed
Source: DWR 2005, CDF 2005.

Basin Plan Status

The Sacramento River and San Joaquin River Basin Plan (Revised September 2004, Fourth Edition) describes beneficial uses for waters within the Tuolumne River Subwatershed. Table 3-117 lists the beneficial uses of the Tuolumne River from the source to Don Pedro Reservoir.

Table 3-117. Beneficial Uses in the Tuolumne River

Beneficial Uses	Tuolumne River
Municipal & Domestic	E,P
Irrigation	E
Stock Watering	E
Process	
Service Supply	
Power	E
Rec-1 (Contact)	E
Rec-2 (Noncontact)	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Migration—Warm	
Migration—Cold	
Spawning—Warm	
Spawning—Cold	
Wildlife Habitat	E
Navigation	

P = Potential, E = Existing, U = Undefined.
Source: Sacramento–San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list.

Within the Tuolumne River subwatershed, Don Pedro Reservoir (11,056 acres) is listed as impaired for mercury in the 2002 Section 303(d) list that was last updated by the EPA in July 2003 (Table 3-118). Resource extraction (mining) is listed as the potential source for the elevated levels of mercury.

Table 3-118. Impaired Designation for Don Pedro Reservoir

Watershed/Subwatershed	Pollutant	TMDL Priority	Approximate Size Affected
Don Pedro Reservoir	Mercury	Low	11,056 acres

Source: CWA Section 303(d)

Table 3-119 shows some of the federal and state criteria for mercury. Mercury criteria are either for total or for inorganic mercury.

Table 3-119. Water Quality Criteria for Mercury

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)		
Compound	DFG—Chronic	DFG—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL	CDHS Action Level	CTR
Mercury	NA	NA	0.77 (total)	1.4 (total)	2.0 (inorganic)	NA	0.05 (total)

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. CTR values are the 30-day average values for drinking water for the California Toxics Rule.

Sources: EPA 2004; Central Valley Water Board 2005. The EPA has established a tissue residue criterion of 0.3 mg methylmercury/kg fish (EPA 2001).

Water Quality

Other than elevated mercury levels, there are no known water quality problems in the upper Tuolumne River watershed. The USGS water quality database does not provide data for mercury in the water column in or near Don Pedro Lake. The determination of impairment was based on measurements of mercury in the tissue of predatory fish (largemouth bass). Between 1981 and 1987, 32 fish were sampled and found to have an average methylmercury concentration of 0.54 mg/kg (Central Valley Water Board 2001). This is greater than the EPA criterion of 0.3 mg methylmercury/kg for fish (EPA 2001).

Tulare Lake Basin—Kings River Subwatershed

The Kings River Subwatershed is located just east of Fresno in the foothills and extends high into the Sierra Nevada Mountains. The Kings River Subwatershed is located primarily within Fresno County with Madera County to the north, and Tulare and Kings Counties to the south. The Kings River Subwatershed is approximately 1,183,534 acres. Figure 3-44 delineates the Kings River Subwatershed. The elevation ranges widely in the Kings River Subwatershed, from a minimum elevation of 381 feet above sea level to a maximum elevation of 14,242 feet, with, a mean elevation of 6,670 feet (DWR 2005).

The climate of the area is arid to semi-arid with dry, hot summers and mild winters. In lower elevations, summer temperatures may be higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing in lower elevations, while some higher elevations in the upper watershed experience extended freezing periods (Jones & Stokes 1998). The lower elevations in the region average less than 10 inches of annual rainfall. The winter snowpack, which accumulates primarily above 5,000 feet elevation in the Sierra Nevada Mountains, supplies the vast majority of water in the basin.

General Watershed Description

Kings River/Pine Flat Reservoir

The two major water features in the Kings River Subwatershed are the Kings River and Pine Flat Reservoir. The Pine Flat Reservoir makes up the lower boundary of the Kings River Subwatershed. Note: because the release from Pine Flat Dam is within the South Valley Floor Subwatershed, the dam and its released waters are discussed in detail in the South Valley Floor Subwatershed section. Virtually all irrigated agriculture is located downstream of Pine Flat Reservoir.

The North Fork Kings River and the Main Fork Kings River feed Pine Flat Reservoir. The many small tributaries on the North Fork of the Kings River include Dinkey Creek, Basin Creek, Patterson Creek, Weir Creek, Williams Creek, Teakettle Creek, Rancheria Creek, and Long Meadow Creek. The North Fork Kings River is steep sided canyon watershed and as a result, no irrigated agriculture is associated with this watershed, and these small tributaries are not discussed in detail. At the confluence of the South Fork Kings River and the Middle Fork Kings River the many small tributaries include Mill Flat Creek, Verplank Creek, Converse Creek, Spring Creek, Cabin Creek, Garlic Meadow Creek, Rough Creek, Tenmile Creek. The South Fork Kings River tributaries include Lockwood Creek, Redwood Creek, and Boulder Creek among others. The Middle Fork Kings River tributaries include Tombstone Creek, Wren Creek, Silver Creek, Crown Creek, and Crystal Creek among others. This analysis does not discuss these small creeks in detail. The South Fork and Middle Fork Kings River are also steep sided canyon watersheds and there is virtually no agriculture within these watersheds. In October of 1968 the Wild and Scenic Rivers Act was passed to protect designated rivers from degradation. Portions of the Upper Kings River are listed as a wild and scenic river under the Wild and Scenic River Act. The designated area is from the confluence of the Middle Fork and the South Fork to the point at elevation 1,595 feet above mean sea level. The Middle Fork from its headwaters at Lake Helen to its confluence with the main stem. The South Fork from its headwaters at Lake 11599 to its confluence with the main stem. The Kings River is divided into 65.5 miles of Wild, and 15.5 miles of Recreational.

CDEC contains flow data for Kings River above Pine Flat Reservoir. Monthly average flows for two locations on the Kings River from 1997–2004 are included in Table 3-120 below.

Table 3-120. Monthly Average Flows on the Kings River

	North Fork Kings River below Dinkey Creek			Kings River at Meadowbrook		
	Min	Mean	Max	Min	Mean	Max
Jan	59	201	470	0	9	15
Feb	71	205	398	0	10	18
Mar	227	350	451	0	27	85
Apr	402	512	700	0	69	155
May	350	665	1,006	0	188	346
Jun	94	235	464	0	163	506
Jul	45	55	73	0	77	503
Aug	38	42	47	0	11	67
Sep	37	41	47	0	4	18
Oct	32	51	99	0	2	6
Nov	44	82	143	0	6	17
Dec	40	83	122	0	6	15

Data on the North Fork Kings River are from 1999 to 2004, and the Kings River at Meadowbrook data are from 1997 to 2004.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only source of land use data where crop types could be identified and delineated by drainage areas. The FRAP data was used as a supplement to the DWR data since the DWR data set is incomplete in some areas. The DWR land use data were used for the purposes of mapping land use. DWR was only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

The majority of land use within the Kings River Subwatershed is made up of native vegetation such as conifer, hardwood, herbaceous, and shrub. Urban land use within the Kings River Subwatershed is approximately 1,500 acres, or 0.13%. Urban lands include those designated by DWR as industrial, residential, urban, urban landscape, and FRAP urban. Total irrigated agriculture is

2,816 acres, or 0.24%. Irrigated agriculture includes citrus and subtropical, deciduous fruits and nuts, grain and hay crops, pasture, semiagriculture, truck, nursery, berry crops and lands designated by FRAP as agriculture. Table 3-121 shows DWR land use for the Kings River Subwatershed. See also Figure 3-54.

Table 3-121. Land Use Acreage according to DWR and FRAP Land Use Data for the Kings River Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	2,560	0.2163
Deciduous Fruits and Nuts	55	0.0046
Field Crops	10	0.0009
Grain and Hay	5	0.0004
Pasture	25	0.0021
Semiagricultural and Incidental	33	0.0028
Truck, Nursery, and Berry Crops	7	0.0006
Subtotal	2,695	0.2277
Urban		
Urban—unclassified	3	0.0003
Urban Landscape	1	0.0001
Urban Residential	1,032	0.0872
Industrial	0.02	0.000002
Vacant	0.01	0.000001
Subtotal	1,036.03	0.087603
Native		
Native Vegetation	96,826	8.1811
Water Surface	3,409	0.2881
Subtotal	100,235	8.4692
FRAP Land Use Type		
Agriculture	121	0.01
Barren/Other	235,833	19.93
Conifer	530,543	44.83
Hardwood	181,667	15.35
Herbaceous	33,902	2.86
Shrub	79,947	6.75
Urban	466	0.04
Water	12,540	1.06
Wetland	4,548	0.38
Subtotal	1,079,567	91.21
Total	**1,183,534**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments), describes beneficial uses for waters within the Kings River Subwatershed. Table 3-122 lists the beneficial uses of the Kings River (Upper North Fork, Main Fork above Kirch Flat, and Kirch Flat to Pine Flat Dam).

Table 3-122. Beneficial Uses of the Kings River Subwatershed

	Kings River		
Beneficial Uses	Upper North Fork	Main Fork (above Kirch Flat)	Kirch Flat to Pine Flat Dam (Pine Flat Reservoir)
Municipal & Domestic		E	
Irrigation			
Stock Watering			
Proc			
Ind			
Power	E		E
Rec-1	E	E	E
Rec-2	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold	E	E	E
SPWN	E	E	
Wildlife Habitat	E	E	E
RARE	E	E	
Groundwater Recharge			
Fresh Water Replenishment	E	E	E

P = Potential; E = Existing; U = Undefined

RARE = Rare, threatened, or endangered species; SPWN = Spawning, reproduction and or early development.

Source: Central Valley Water Board 1995.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are not expected to meet water quality standards, or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. The Kings River is not listed as impaired in the 2002 CWA Section 303(d) List that was last updated and approved by the EPA in July of 2003.

However, it is important to note that the Lower Kings River (located in the South Valley Floor Subwatershed) (Island Weir to Stinson and Empire Weir) is listed as impaired on the 303(d) list Impairments include EC, molybdenum, and toxaphene.

Water Quality

The water quality on the Upper Kings River is of good to excellent quality. As stated earlier, no 303(d) listed pollutants are associated with the Upper Kings River. This is likely attributable to most of the watershed being included in the Kings Canyon National Park and the John Muir Wilderness. There is very little urbanization in the Kings River subwatershed and irrigated agriculture accounts for only 0.24 percent of the land use. Generally, all physical parameters such as EC, pH, temperature, and turbidity are within Basin Plan standards. However, it is important to note that the lower Kings River is listed on CWA Section 303(d) list as impaired for EC, molybdenum, and toxaphene. These impairments are discussed in detail in the South Valley Floor Subwatershed section.

Tulare Lake Basin—Kaweah River Subwatershed

General Description

The Kaweah River Subwatershed is located just south of the Kings River Subwatershed as part of the Tulare Lake Basin. Its western boundary is defined where the foothills meet the valley floor. The Kaweah River Subwatershed is approximately 600,093 acres (about 938 square miles) in size. The topography of the Kaweah River Subwatershed is similar to the Kings River Subwatershed. The minimum elevation is 400 feet, the mean elevation is 4,080 feet, and the maximum elevation is 12,569 feet (DWR 2005). The two major water features in the Kaweah River Subwatershed are Lake Kaweah, and the Kaweah River. Drainage from Lake Kaweah is outside of the subwatershed and is discussed in further detail in the South Valley Subwatershed section. Figure 3-45 delineates the Kaweah River Subwatershed.

The climate of the area is arid to semi-arid with dry, hot summers, and mild winters. Summer temperatures may be higher than 100°F for extended periods of time. Winter temperatures are occasionally below freezing in lower elevations, with some higher elevations in the upper watershed experiencing extended freezing periods (Jones & Stokes 1998). The region averages less than 10 inches of annual rainfall. The winter snowpack, which accumulates above 5,000 feet elevation, primarily in the Sierra Nevada Mountains, supplies the vast majority of water in the basin. The west side streams contribute little to the water totals in the Tulare Lake Basinbecause the Coast Range Mountains are too low to accumulate a snowpack and the east slope is subject to a rain shadow phenomenon, therefore producing only seasonal runoff.

Upper Kaweah River/Lake Kaweah

The upper Kaweah River contains three main arms; the North, Middle, and South Forks. All three arms confluence to form Lake Kaweah. Each arm of the Kaweah has many smaller tributaries. Some of the main tributaries to the North Fork Kaweah are Mankins Creek, Sheep Creek, Yucca Creek, Eshom Creek, Pierce Creek, Redwood Creek, Stoney Creek, Marble Fork, and Dorst Creek. It is important to note that the Middle Fork Kaweah also has an East Fork Kaweah branch. The Middle Fork Kaweah is by far the largest of the three arms. Some of the main tributaries that make up the Middle Fork Kaweah River include, Salt Creek, the East Fork Kaweah River, Squirrel Creek, Elk Creek, Panther Creek, Dome Creek, Castle Creek, Mehrten Creek, Buck Creek, Cliff Creek, Granite Creek, and Lone Pine Creek. Some of the main tributaries that make up the South Fork Kaweah River include Gray Creek, Cinnamon Creek, Grouse Creek, Bennett Creek, Squaw Creek, Cedar Creek, Garfield Creek, and Hunter Creek. However, many of these smaller tributaries are ephemeral streams depending on the amount of snow pack or the duration of a storm.

For this analysis, only the three main arms are discussed in further detail due to the lack of data on all of the smaller tributaries. The USGS website contains flow information for various locations on the Kaweah River. However, the Middle Fork Kaweah River is the only arm that contains flows just above Lake Kaweah. The Kaweah River below Lake Kaweah is not within this Subwatershed but in South Valley Floor Subwatershed and is further discussed in that section. Monthly average USGS flows for the Middle Fork Kaweah River from 1985 to 1990 are found in Table 3-123 below.

Table 3-123. Kaweah River Flows from 1985 to 1990 (11208600)

	Minimum	Mean	Maximum
Jan	27	186	1,250
Feb	32	170	439
Mar	82	275	529
Apr	234	442	633
May	382	795	1,051
Jun	134	667	2,039
Jul	13	312	1,512
Aug	14	66	244
Sep	8	23	87
Oct	12	24	60
Nov	11	78	335
Dec	16	66	271

Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only source of land use data where crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data was used as a supplement to the DWR data since the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Because this subwatershed is located in the higher elevations, the majority of land use is native vegetation. According to DWR data, native vegetation accounts for approximately 18% of the subwatershed, while the FRAP conifer, hardwood, herbaceous, and shrub account for approximately 77%. Urban land use accounts for approximately 829 acres or 0.13% of the subwatershed. Table 3-124 categorizes the various DWR and FRAP land uses (DWR 2005).

Irrigated agriculture accounts for only a small amount of land within the Kaweah River subwatershed. This is primarily due to the topography of the land. The total irrigated agriculture was calculated by combining DWR citrus, subtropical, deciduous fruits and nuts, field crops, grain and hay crops, pasture, semiagriculture, vineyards, and FRAP agriculture. The total irrigated agriculture is approximately 2,768 acres or 0.5% of the Kaweah River Subwatershed. It’s important to note that pasture may or may not be irrigated land. However, pasture only accounts for 76 acres within this subwatershed. The largest irrigated crop within this subwatershed is citrus and subtropical accounting for approximately 0.4% of the total 0.5% of irrigated agriculture, which is equal to 84% of the total agriculture. Figure 3-55, identifies the land use within the Kaweah River Subwatershed (DWR 2005).

Table 3-124. Land Use Acreage according to DWR and FRAP Land Use Data for the Kaweah River Subwatershed

DWR Land Use	Acres	Percent Total
Agriculture		
Citrus and Subtropical	2,205	0.367
Deciduous Fruits and Nuts	149	0.025
Field Crops	87	0.014
Grain and Hay	5	0.001
Idle	6	0.001
Pasture	76	0.013
Semiagricultural and Incidental	49	0.008
Vineyards	37	0.006
Subtotal	2,614	0.435
Urban		
Urban—unclassified	10	0.002
Urban Landscape	5	0.001
Urban Residential	240	0.040
Commercial	0.12	0.00002
Industrial	6	0.001
Vacant	7	0.001
Subtotal	268.12	0.04502
Native		
Native Vegetation	105,288	17.545
Riparian Vegetation	21	0.004
Water Surface	43	0.007
Subtotal	105,352	17.556
FRAP Land Use Type		
Agriculture	118	0.020
Barren/Other	29,057	4.842
Conifer	132,704	22.114
Hardwood	239,916	39.980
Herbaceous	48,954	8.158
Shrub	37,621	6.269
Urban	554	0.092
Water	2,726	0.454
Wetland	208	0.035
Subtotal	491,858	81.964
Total	**600,093**	**100**

Sources: DWR 2005, CDF 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the Kaweah River Subwatershed. Table 3-125 lsits the beneficial uses of the upper Kaweah River and Kaweah Lake.

Table 3-125. Beneficial Uses of Kaweah River and Kaweah Lake

Beneficial Uses	Kaweah River	
	Above Lake Kaweah	Lake Kaweah
Municipal & Domestic	E	
Irrigation		
Stock Watering		
Proc		
Ind		
Power	E	E
Rec-1	E	E
Rec-2	E	E
Freshwater Habitat—Warm	E	E
Freshwater Habitat—Cold	E	
SPWN	E	
Wildlife Habitat	E	E
RARE	E	
Groundwater Recharge		
Fresh Water Replenishment	E	E

P = Potential, E = Existing, U = Undefined.

RARE = Rare, Threatened, or Endangered Species. SPWN = Spawning, reproduction and or early development.

Data obtained from the Sacramento San Joaquin River Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards, or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. The Kaweah River is not listed as impaired in the 2002 CWA Section 303(d) List that was last updated by the EPA in July of 2003. In addition, Kaweah Lake is not listed as impaired.

Water Quality

The Southern San Joaquin Valley Water Quality Coalition monitored four locations on the Kaweah River. For one sampling event, the water quality data did not indicate that agricultural contamination was present (SJVWQC 2005). However, it is important to note that these four sampling locations were downstream of Kaweah Lake and are outside of the Kaweah River Subwatershed. The State of the Watershed Report for Tulare Lake Watershed in the Water Management Initiative noted that Kaweah Basin contained elevated levels of copper, arsenic, and silver (Central Valley Water Board and CalEPA 2002). The Kaweah River is not listed on the CWA Section 303(d) list for any impairments.

Tulare Lake Basin—
Kern River Subwatershed

General Description

The Kern River Subwatershed is the second largest subwatershed within the Tulare Lake Basinand is approximately 1,517,632 acres. The Kern River Subwatershed is bordered on the north by the Kings River subwatershed, on the west by the Southern Sierra subwatershed, on the east by the Sierra Nevada Mountains, and to the south by the Grapevine subwateshed. The topography of the Kern River Subwatershed is consistent with the Kings River and Kaweah River Subwatershed and is dominated by steep river canyons and large mountains. The minimum elevation is 489 feet, while the mean elevation is 6,791 feet and the maximum elevation is 14,478 feet. Figure 3-46 shows the Kern River Subwatershed boundaries.

The climate of the area is arid to semi-arid with dry, hot summers and mild winters. In lower elevations, summer temperatures may be higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing. The higher elevations in the upper watershed experience extended freezing periods and far more precipitation (Jones & Stokes 1998). The lower elevations in the region average less than 10 inches of annual rainfall. The winter snowpack, which accumulates above 5,000 feet elevation, primarily in the Sierra Nevada Mountains, supplies the vast majority of water in the basin.

The primary water features in the Kern River Subwatershed are the Kern River, South Fork Kern River, Isabella Lake, and Kern River outflow from Isabella Lake.

Kern River

The headwaters of the Kern River originate in the Kings Kern Divide, from which the river travels through Kern Canyon in Sequoia National Park. The Kern

River flows south, passing west of Mt. Whitney and through the Golden Trout Wilderness Area. Along its route, the Kern River collects many small creeks. The west side tributaries from north to south include Milestone Creek, Red Spur Creek, Chagoopa Creek, Funston Creek, Big Arroyo Creek, Rattlesnake Creek, Laurel Creek, Coyote Creek, Little Kern Lake Creek, Grasshopper Creek, Leggett Creek, Little Kern River, Freeman Creek, Needle Rock Creek, Peppermint Creek, Meadow Creek, South Creek, Tobias Creek, and Bull Run Creek; after Bull Run Creek, the Kern River becomes the north fork arm of Isabella Lake. The east side tributaries include Tundall Creek, Wallace Creek, Whitney Creek, Rock Creek, Golden Trout Creek, Cold Creek, Nine Mile Creek, Osa Creek, Soda Creek, Rattlesnake Creek, Durrwood Creek, Brush Creek, Salmon Creek, Gold Ledge Creek, Corral Creek, Cannell Creek, and Caldwell Creek. No flow data are available for this part of the Kern River. However, downstream flow data are available and shown in Table 3-126.

In October of 1968 the Wild and Scenic Rivers Act was passed to protect designated rivers from degradation. The Kern River is listed as a wild and scenic river under the Wild and Scenic River Act. The designated area is the North Fork from the Tulare-Kern County line to its headwaters in Sequoia National Park. The South Fork from its headwaters in the Inyo National Forest to the southern boundary of the Domelands Wilderness in the Sequoia National Forest. The designated classification is broken up into 123.1 miles of Wild, 20.9 miles of Scenic, and 7 miles of recreational.

South Fork Kern River

The headwaters of the South Fork Kern River originate just southeast of the main Kern River next to the Golden Trout Wilderness Area, from which the river travels down through the Rainshaw and Templeton Meadows. As the South Fork flows south through the South Sierra Wilderness Area, the river picks up many small inflows from creeks on both the west and east sides. The west side creeks from north to south include Kern Peak Stringer, Lewis Stringer, Strawberry Creek, Shaeffer Stringer, Soda Creek, Round Mt. Stringer, Snake Creek, Crag Creek, Lost Creek, Bitter Creek, Fish Creek, Trout Creek, Tibbets Creek, Manter Creek, Taylor Creek, and Bartolas Creek, after which the South Fork Kern River becomes the south arm of Isabella Lake. The east side of the South Fork tributaries include Mulkey Creek, Dry Creek, Long Stringer, Monache Creek, Summit Creek, Honeybee Creek, Canebrake Creek, and Kelso Creek. Monthly average flow for the South Fork Kern River is included in Table 3-126 below.

Isabella Lake/Kern River

Isabella Lake, also located in Sequoia National Forest has a storage capacity of 568,000 acre-feet (DWR 2005). The north fork arm of Isabella Lake is the smaller of the two arms; the community of Wafford Heights lies just west. The south fork arm is the larger arm; some small communities are located on this arm, such as Mountain Mesa, South Lake, and Bella Vista. The Kern River discharge from Isabella Dam flows southwest down into the valley floor, passes through Bakersfield, and ultimately empties into the Outlet Canal that feeds the East and West Side Canal. Once the Kern River reaches the valley floor, it is outside of the Kern River Subwatershed; this part of the river is analyzed as part of the South Valley Floor Subwatershed. Monthly average flow from the USGS website is shown in Table 3-126 below. Flow at Kern River near Democrat Springs, just downstream of Isabella Dam, is the total outflow from Isabella Dam and represents the combination of inflow from the main Kern River arm and the South Fork Kern River.

Table 3-126. Monthly Average Flow (1994–2004) on the Kern River near Democrat Springs (11192501), and South Fork Kern River (11189500)

	Kern River near Democrat Springs (11192501)			South Fork Kern River near Onyx California (11189500)		
	Min	Mean	Max	Min	Mean	Max
Jan	220	453	921	26	101	500
Feb	300	715	2,467	35	108	240
Mar	379	811	2,441	64	198	493
Apr	409	988	2,046	84	328	923
May	551	1,436	3,693	52	340	1,465
Jun	911	1,961	4,593	18	154	915
Jul	943	1,824	3,735	2	48	279
Aug	576	1,508	3,315	1	21	84
Sep	281	842	1,805	1	16	57
Oct	216	634	1,451	8	22	51
Nov	190	574	1,497	22	66	293
Dec	254	465	1,336	23	49	117

Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Urban land use equals a very small portion of the land use within the Kern River Subwatershed. The total urban land use is 6,656 acres, which is 0.4% of the total acreage within the subwatershed. Urban lands include those designated by DWR as commercial, industrial, residential, urban, urban landscape, and by FRAP as urban.

The total irrigated land within the subwatershed is 4,676 acres or 0.3% of the Subwatershed. Irrigated agricultural lands include those designated by DWR as citrus and subtropical, deciduous fruits and nuts, field crops, grain and hay crops, pasture, semi-agriculture, truck, nursery, and berry crops.

Native vegetation is the dominant land use designation within the Kern River Subwatershed. Table 3-127 contains DWR and FRAP land use for the Kern River Subwatershed. See also Figure 3-56.

Table 3-127. Land Use Acreage according to DWR and FRAP Land Use Data for the Kern River Subwatershed

DWR Land Use	Acres	Percent Total
Agriculture		
Citrus and Subtropical	69	0.005
Deciduous Fruits and Nuts	55	0.004
Field Crops	18	0.001
Grain and Hay	795	0.052
Idle	44	0.003
Pasture	2,943	0.194
Semiagricultural and Incidental	103	0.007
Truck, Nursery, and Berry Crops	693	0.046
Subtotal	4,720	0.312
Urban		
Urban—classified	2,525	0.166
Urban Landscape	82	0.005
Urban Residential	3,230	0.213
Commercial	154	0.010
Industrial	57	0.004
Vacant	124	0.008
Subtotal	6,172	0.406
Native		
Native Vegetation	213,174	14.046
Riparian Vegetation	3,182	0.210
Water Surface	10,810	0.712
Subtotal	227,166	14.968
FRAP Vegetation		
Barren/Other	110,061	7.252
Conifer	795,863	52.441
Desert	39,596	2.609

Hardwood	98,752	6.507
Herbaceous	50,865	3.352
Shrub	166,111	10.945
Urban	608	0.040
Water	2,666	0.176
Wetland	15,053	0.992
Subtotal	1,279,575	84.314
Total	**1,517,632**	**100**

Source: DWR 2005 and FRAP 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the Kern River Subwatershed. Table 3-128 lists the beneficial uses of the Kern River (Above Lake Isabella, Lake Isabella, and Lake Isabella to Kern River Powerhouse No.1).

Table 3-128. Beneficial Uses according to the Tulare Lake Basin, Water Quality Control Plan

	Kern River		
Beneficial Uses	Above Lake Isabella	Lake Isabella	Lake Isabella to Kern River Powerhouse No. 1
Municipal & Domestic	E		
Irrigation			
Stock Watering			
Proc			
Ind			
Power	E	E	E
Rec-1	E	E	E
Rec-2	E	E	E
Freshwater Habitat—Warm	E	E	E
Freshwater Habitat—Cold	E	E	E
SPWN	E		
Wildlife Habitat	E		E
RARE	E		E
Groundwater Recharge			
Freshwater Replenishment	E	E	

P = Potential; E = Existing; U = Undefined; RARE = Rare, threatened, or endangered species; SPWN = Spawning, reproduction and/or early development.
Source: Central Valley Water Board 1995.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet or are expected not to meet water quality standards, or are considered impaired. The affected water body and associated pollutant are then prioritized in the 303(d) list. The Kern River is not listed as impaired in the 2002 CWA Section 303(d) list that was last updated and approved by the EPA in July of 2003.

Water Quality

The water quality on the Upper Kern River is excellent. As stated earlier, no 303(d) listed pollutants are associated with the Upper Kern River. This is likely attributable to this watershed being primarily in the Sequoia National Park, Sequoia National Forest, and Golden Trout Wilderness. There is very little urban development or irrigated agriculture in this subwatershed. Generally, all physical parameters such as EC, pH, temperature, and turbidity are within Basin Plan standards.

Tulare Lake Basin—
South Valley Floor Subwatershed

General Description

The South Valley Floor Subwatershed (SVFS) is bound on the north by the San Joaquin River and to the south by the Grapevine Subwatershed. To the west is the Coast Range, Sunflower, Temblor, Fellows Subwatersheds, and to the east are the Kings River, Kaweah River, Southern Sierra, and Kern River Subwatersheds. The SVFS is the largest subwatershed within the Tulare Lake Basinat approximately 5,270,363 acres (about 8235 square miles). Figure 3-47 delineates the boundaries for the SVFS. The general topography of the SVFS is relatively flat in comparison to the surrounding subwatersheds. Elevation ranges from 154 feet to 4,131 feet around the base of some of the dams (USGS 2005b). The main natural water features in the SVFS include the Kings River, the Kaweah River, the Tule River, the Kern River, and the Westside drainages. The Friant-Kern Canal, the San Luis Canal, and the Cross-Valley Canal are major water delivery facilities that have dramatically altered the way water is managed in the SVFS.

The climate in the Tulare Basin is characterized by hot summers and mild winters. The Fresno area receives 10–11 inches of rain per year, while the southern San Joaquin Valley floor, specifically Kern County, receives an average of less than 5–6 inches of precipitation per year due largely to the rain shadow caused by the Coast Range Mountains. Precipitation in the Coast Range Mountains varies from less than 10 inches to more than 20 inches per year.

The dominant land use and industry in the SVFS is far and away agriculture. Fresno, Tulare, Kings, and Kern Counties are among the most productive agricultural counties in the world. Much of the water that once maintained historic Tulare and Buena Vista Lakes has been captured by reservoirs and is now used extensively to produce crops. Much of the water distribution system is comprised of historic river channels and sloughs, and water is moved from one end of the valley to the next as needed. On the West side of the valley, irrigation water is supplied through the San Luis Canal, which is the joint federal/state section of the California Aqueduct that delivers water from the Sacramento–San Joaquin Delta, and San Luis Reservoir. On the East side of the valley, water is supplied from Millerton Lake through various turnouts on the Friant-Kern Canal. The Cross Valley Canal is a locally owned facility and is operated through a joint use agreement. The Friant-Kern Canal is operated by the Bureau of Reclamation, and can deliver water to any number of contract, and non-contract, holders through various physical and institutional arrangements. Pine Flat Reservoir, Lake Kaweah, Lake Success, and Lake Isabella are operated by the Corps and likewise can deliver water to any number of contractors. Many of the larger landholders in the basin have either contracts or agreements to use water from many of the reservoirs in the area, and can take water through numerous facilities. An example is the Arvin-Edison Water Storage District who contracts for water from Millerton Reservoir, but also has the capability through exchange agreements to store water from the Califorinia Aqueduct via the Cross-Valley Canal. In another example, Fresno Irrigation District has contracts with Reclamation for Millerton Reservoir water, and with the Corps for Kings River Water. Many of the irrigation districts and landholders also have agreements among themselves to exchange water in various year types and under certain circumstances. Because of the relatively dry conditions in the Tulare Lake Basin, most water in the basin is spoken for except in very wet conditions when there isn’t enough local surface storage to capture large flows. There are also numerous agreements between water storage districts and water agencies in the valley and Califorina Aqueduct contractors to store water in groundwater banks in the SVFS for withdrawl or exchange during dry years.

While providing irrigation water, many of the reservoirs were also constructed to minimize flooding in the Tulare Lake Bed, as this area has been intensively farmed for decades, and the Tulare Lake Basin is for all intensive purposes now hydologically closed (as very little water flows to the San Joaquin River through North Kings River). Because of the intensive water development that has occurred in the SVFS, and in the subwatersheds directly to the east in the Sierra Nevada Mountain foothills, there are very few channels that are not specifically maintained as water delivery features. While many of the historic channels provide recreation and fishing for some distance from the five main reservoirs in the foothills, flow in all of these channels is managed to provide irrigation and domestic supplies to water users in the SVFS. This manipulation and commingling of many water sources has changed the hydrology and water quality characteristics of the basin. However, because many of the once natural channels are maintained as water delivery features, there has been little monitoring and characterization of the water quality by anyone other than those who rely on these features for their livelihood.

Lower Kings River

The Kings River originates in the southern Sierra Nevada Mountains and flows west toward the Tulare Basin. The upper Kings River, including Pine Flat Reservoir, is located outside of the SVFS. This analysis covers the lower Kings River discharge from Pine Flat Reservoir. Just below Pine Flat Reservoir the river flows southwest in a single channel and passes near Centerville where it splits into multiple channels, then converges as a single channel downstream of Centerville Bottoms. Near Kingsburg, the river is confined by a continuous levee system that continues through the lower reaches of the river. The Kings River ends by draining into the Tulare Lake Canal, which, in turn, merges with the Tule River approximately 9 miles southwest of the town of Stratford.

The Basin Plan divides the Kings River into 5 reaches. Reach one is everything above Kirch Flat Reservoir, and reach two is from Kirch Flat to Pine Flat Dam. Both reach one and two are in the Kings River Subwatershed. Reach three, four, and five are within this discussion. Reach three extends from Pine Flat Reservoir to the Friant Kern Canal. Reach four extends from the Friant Kern Canal to Peoples Weir, and reach five extends from Peoples Weir to Island Weir. In addition, the Kings River Conservation District recognizes two additional reaches in the Lower Kings River. The first reach is from Island Weir to Stinson Weir on the North Fork of the Kings, and to Empire Weir No.2 on the South Fork. The second reach is from Stinson Weir to James Weir on the North Fork of the Kings River (Kings River Conservation District, Water Quality Report for the Kings River for the Period 1978–1999, Vol. 1, December 2000).

Army weir, located at the head of the Clarks and South Fork, is the main flow diversion. The Crescent Bypass when operated in conjunction with the Crescent Weir, provides a secondary diversion to the South Fork. However, the Cresent Weir can also relay water back and fourth between the two forks. The Kings River system capacity progressively decreases downstream, from 50,000 cfs below Pine Flat Dam to 11,000 cfs at the head of Army Weir. Data indicate flow does not typically exceed 5,000 cfs in high-flow months and low-flow months can have no flow (Table 3-129) (Kings River Conservation District 2005). The Kings River, during extreme high flow conditions spills into the Fresno Slough and flows into the San Joaquin River. These flood flows represent the only significant outflows from the basin (Kings River Conservation District 2005).

Lower Kaweah River

The Kaweah River originates in the Sierra Nevada Mountains at an elevation of 12,000 feet, flowing generally westward toward the South Valley. The South Valley portion of the Kaweah Subwatershed includes Kaweah River below Terminus Reservoir and St. Johns River. The main tributaries to this segment of the lower Kaweah River are Dry Creek and Yokohl Creek. Annual spring runoff from Dry Creek provides sufficient inflow to contribute to Kaweah River’s flow. The intermittent Yokohl Creek only has adequate flow to reach Kaweah River during years with above-normal precipitation (Kaweah and St. Johns Rivers

Association 2005). There are also Mill Creek, Packwood Creek, Cameron Creek, and Elk Bayou that flow into the lower Kaweah River. The City of Visalia discharges it's treated effluent into Mill Creek, which ultimately flows into the Kaweah River.

St. Johns River originates from the Kaweah River downstream of Terminus Reservoir at McKay Point and flows southwest where it bends and flows northwest of Visalia into Cross Creek. There are several agricultural irrigation diversions that reduce the flow of St. Johns River prior to reaching Cross Creek. These diversions include Longs Canal, Sweeney Ditch, Ketchum Ditch, Packwood Canal, Tulare ID Main Canal, Mathews Ditch, Jennings Ditch, Uphill Ditch, Modoc Ditch, St. Johns Ditch, Goshen Ditch, Lakeside Ditch, and Lakelands Canal No. 2. Major public districts within the Kaweah River system include Tulare ID, Exeter ID, Ivanhoe ID, Lakeside Irrigation WD, a portion of Corcoran ID, and Stone Corral ID. Water is diverted from St. Johns and the Lower Kaweah Rivers and distributed through a complex system of natural channels and manmade canals owned and operated by numerous agencies and entitlement holders. There are additional foothill watersheds that have the potential to generate runoff which reaches the southern San Joaquin Valley floor only in above average precipitation conditions. These watersheds include Sand Creek, Stokes Mountain, Cottonwood Creek, and Lewis Creek (Kaweah and St. Johns Rivers Associations 2005).

The Friant Kern Canal plays a large role in the hydrology of the Kaweah River. Exeter, Ivanhoe, Stone Corral, and Tulare IDs have long-term water service contracts with the United States Bureau of Reclamation for CVP water. Water is delivered through turnouts, where the Friant-Kern Canal crosses the Tulare Irrigation Main Canal, the St. Johns River channel, and the lower Kaweah River channel.

Lower Tule River

The North, Middle, and South Forks of the upper portion of the Tule River flow out of the Sierra Nevada foothills into Lake Success. Below Lake Success, Tule River enters the SVFS, flowing through Porterville and across the southern San Joaquin Valley floor for about 40 miles to the Tulare Lakebed. Porter Slough, which begins at Tule River downstream of Bartlett Park, is used for diverting flood and irrigation releases from Success Reservoir northwest approximately 2 miles. The Tule River divides into South, Middle and North Forks north of the community of Woodville, and remains divided for several miles. The South and Middle forks reunite east of SR 99 and the South and North forks reunite west of SR 99. There are numerous irrigation diversions along Tule River and many connecting inflows from the Kaweah River that enter Tule River prior to reaching the Tulare Lakebed, including Elk Bayou and Cross Creek. Tule River water reaching the Tulare Lakebed is stored for future irrigation, or evaporates (Tule River Association 2005). Additional irrigation districts include the Terra Bella ID, the Saucelito ID, Porterville ID, Lindmore ID, Lower Tule River ID, Delano-Earlimart ID, and the Pixley ID. Natural flow in Tule River is highly manipulated from these irrigation districts. During the summer months, the

Irrigation Districts routinely take water from the natural channels, leaving the channels dry. The water is then run through canals and discharged back to the river channels resulting in alternating wet and dry lengths of the river system. The Friant Kern Canal also plays a large role in providing flow in Tule River during summer months.

Deer Creek and White River are both located south of Tule River and flow west toward Tulare Lake Basin from the Sierra Nevada foothills. Deer Creek near Fountain Springs typically flows year-round with reduced flows from August through October and provides flow to the Pixely National Wildlife Refuge. In dry years there is no flow in August and September. The highest average flows occur in February (82 cfs). The month with the highest average flow for a single year was January 1997, with a flow of 440 cfs (Table 3-129). Further downstream, near Road 104, Dear Creek is channelized and flows into Homeland Canal. White River, near Ducor, has a reduced flow during average years, and no flow from June through November during dry years. In wet years, April has the most flow with 165 cfs, and the lowest flow during September with 5 cfs.

Lower Kern River

While there are some minor streams in the Lower Kern River watershed, such as Poso Creek and Caliente Creek, the Kern River is the only significant source of surface water. Since 1954, when Isabella Dam was completed, all of the Kern River flow has been diverted into conveyance canals below Kern River Canyon. The diverted water is either consumptively used or recharged to groundwater and does not reenter the Kern River. At Kern River Canyon average flows are lowest in November (153 cfs) and highest in June (812 cfs). The Lower Kern River merges into Bueno Vista Lake. From Bueno Vista Lake, the drainage is a flood channel that locals typically refer to as the North Fork of the Kern River. For much of its length the Kern River, the river channel is bordered by major conveyance canals including Cross Canal to the north and Carrier Canal to the south. These conveyance canals receive all discharges, protecting the Kern River water quality. There are also diversions located along the Lower Kern River. These diversion canals include Beardsley Canal, Kern Island Canal, Arvin Edison Canal, and Alejandro Canal. Through urban Bakersfield, flood control levees protect the river’s water quality from discharges. When the river is dry there are intentional surface water discharges from either Friant-Kern Canal or Cross Valley Canal into the Kern River channel for groundwater recharge (Kern County Water Agency 2005). In addition, Poso and Caliente Creeks are part of the watershed. Both Creek are normally dry except for high water years, and both receive canal discharges in the summer months, which results in alternating we and dry portions of the stream channel. The western end of the Kern River also supports the Kern Water Bank. However, the majority of the water that feeds the bank is supplied by the California Aqueduct.

Table 3-129. Flows in the South Valley Floor Subwatershed

Date	Deer Creek near Fountain Springs Min	Mean	Max	Kaweah River Below Terminus Dam Min	Mean	Max	Kern River Below Kern Canyon Diversion Dam Min	Mean	Max	Kings River (CMS) Min	Mean	Max
Jan	10	68	440	53	213	444	21	176	630	0	699	4,715
Feb	16	82	364	65	425	1494	23	316	1,234	0	563	3,796
Mar	21	68	213	25	529	2569	29	344	1,634	0	164	910
Apr	13	64	318	50	349	1775	26	274	1,543	0	543	3,496
May	6	51	211	52	472	1654	18	479	3,378	0	613	4,113
Jun	2	28	153	599	1,216	1,784	16	812	4,191	0	661	4,477
Jul	0.27	11	67	632	1,008	1,801	16	791	3,375	0	669	3,790
Aug	0	5	29	59	313	909	15	528	2,667	0	179	976
Sep	0	4	20	20	61	210	16	201	1,442	0	120	669
Oct	2	5	19	8	19	33	16	155	1,134	0	22	83
Nov	7	18	46	14	32	83	21	153	1,093	0	20	71
Dec	9	30	145	48	200	519	21	160	1,278	0	81	430

Date	Panoche Creek at I-5 near Silver Springs Min	Mean	Max	Tule River Below Success Dam Min	Mean	Max	White River near Ducor Min	Mean	Max
Jan	0	0.4	3	20	94	209	1.95	20	97
Feb	0	46	316	0.27	150	560	3.38	31	155
Mar	0	4	23	10	214	1,096	3.75	30	107
Apr	0	2	11	44	104	368	2.89	28	165
May	0	0.65	4	20	59	95	0.42	18	88
Jun	0	0.63	2	34	122	244	0	8	59
Jul				84	230	382	0	2	21
Aug				46	139	431	0	0.66	7
Sep	No Flow Available			22	69	196	0	0.49	5
Oct				8	63	226	0	0.77	8
Nov				0.52	29	79	0	4	12
Dec	0	0.29	2	3	62	201	0.3	11	29

Kings River—CDEC data from January 1997 to June 2003.
Kern River, Deer Creek, and White River—USGS data from January 1994 to September 2004.
Kaweah River and Tule River—USGS data January 1985 to September 1990.
Panoche Creek—USGS data from December 1997 to June 2004 (January–June, and December for all years).

Westside Drainages

A multitude of ephemeral streams originating in the Coast Range, Tehachapi and San Emigdio Mountains make up the Westside Drainages. These stream channels consist of marine sediments and are highly mineralized. Most of these streams consist of flashy pulse flows. Sustained flow is limited, occurring only after extended wet periods (Central Valley Water Board 2004). For further information on these drainages see the Coast Range, Sunflower, Temblor, and Fellows Subwatershed descriptions.

Tulare Lake Bed

During high flow, Tulare Lake Bed serves as the terminus for both eastern and western valley streams, including runoff from the Kings, Kaweah, Tule, and Kern Rivers. This lakebed, with a bottom elevation of 175 feet is effectively closed. The only natural outlet is the San Joaquin River to the north at an elevation of 207 feet. Water has not risen to this elevation and naturally flowed out of the basin since the 1870s. Development of intensive agriculture in the tributary basins, construction of reservoirs and other flood and water control measures, and land reclamation in the lakebed, have greatly reduced the likelihood of future natural outflows (Kings River Conservation District 2004).

Imported Water

Surface water in the South Valley is not sufficient to support land uses in the subwatershed, causing water to be imported from other locations. Imported surface water supplies include the San Luis Canal/California Aqueduct System, Friant-Kern Canal, and the DMC. The SWP, through the San Luis Reservoir, delivers an average of 1,200,000 acre-feet of California Aqueduct surface water annually to the Tulare Lake Basin. The Bureau of Reclamation delivers a combined 2,700,000 acre-feet to the Tulare Basin, during normal years, from the CVP via Mendota Pool, the Friant-Kern Canal, and San Luis Canal of the CVP/SWP San Luis Joint-Use Facilities (DWR 2005). The majority of this water is used in the South Valley Floor Subwatershed.

The Friant-Kern Canal diverts water from the San Joaquin River below Friant Reservoir, and travels south to deliver water to the southern portions of Kern County. The 151.8-mile Friant-Kern Canal stretches from Millteron Lake to the Kern River, 4 miles west of Bakersfield. Initial capacity of the canal is 5,000 cfs and gradually decreases to 2,000 cfs as water is used for municipal, industrial, and irrigation supplies throughout the South Valley (Reclamation 2005).

Water from the California Aqueduct flows into O’Neill Forebay and water from the DMC can be pumped into O’Neill Forebay. From there, water is either pumped into San Luis Reservoir for storage or continues south in the San Luis Canal. When necessary, often during the irrigation months, stored water from San Luis Reservoir is released back to O’Neill Forebay and either flows south in San Luis Canal to both CVP and SWP contractors, including many in the SVFS, or is released to the DMC for delivery to CVP Exchange Contractors (CALFED 2003). Water can also be moved between the Friant-Kern Canal and the San Luis Canal through the Cross-Valley Canal.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only source of land use data where crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data was used as a supplement to the DWR data since the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Agriculture is the largest land use type, using approximately 66% (3,485,592 acres) of the total land use in the subwatershed. Figure 3-57 includes the specific land uses for the SVFS. Specific land use types defined in DWR's agriculture category include citrus and subtropical, deciduous fruits and nuts, field crops, grain and hay crops, pasture, rice, vineyards, and FRAP's agriculture land use. Table 3-130 includes the individual land use types in acres and calculated percent total of land use. DWR land use types (native vegetation and riparian vegetation) and FRAP land use types (desert, hardwood, herbaceous, and shrub) encompass approximately 25% (1,328,027 acres) of the total land use acreage in the area. DWR's commercial, industrial, residential, urban landscape, and both DWR and FRAP's urban land uses, combine for about 6% (305,153 acres) of the total land use acres. The remaining land uses in the watershed include barren land at 92,032 acres and water surface at 59,564 acres combining for almost 3% of the land use acres.

Table 3-130. Land Use Acreage according to DWR and FRAP Land Use Data for the South Valley Floor Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Citrus and Subtropical	218,174	4.140
Deciduous Fruits and Nuts	524,082	9.944
Field Crops	1,199,547	22.760
Grain and Hay	343,311	6.514
Idle	43,986	0.835
Pasture	394,170	7.479
Rice	14	0.0003
Semiagricultural and Incidental	65,585	1.244
Truck, Nursery, and Berry Crops	285,520	5.417
Vineyards	454,367	8.621
Subtotal	3,528,756	66.9543
Urban		
Urban—unclassified	175,777	3.335
Urban Landscape	13,718	0.260
Urban Residential	36,778	0.698
Commercial	10,602	0.201
Industrial	60,789	1.153
Vacant	47,990	0.911
Subtotal	345,654	6.558
Native		
Native Vegetation	1,082,402	20.537
Barren and Wasteland	56	0.001
Riparian Vegetation	41,848	0.794
Water Surface	59,292	1.125
Subtotal	1,183,598	22.457
FRAP Land Use Type		
Agriculture	821	0.016
Desert	29,424	0.558
Hardwood	1,183	0.022
Herbaceous	171,946	3.263
Shrub	1,224	0.023
Urban	7,490	0.142
Water	272	0.005
Subtotal	212,360	4.029
Total	**5,270,368**	**100**

Source: DWR 2005b; CDF 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the South Valley Floor Subwatershed. Table 3-131 lists the beneficial uses of Kings River (Pine Flant dam to Stinson and Empire Weirs), Kaweah River (Below Lake Kaweah), Tule River (Below Lake Success), Kern River (Below KR-1), West Side Streams, and Valley Floor Waters.

Table 3-131. Beneficial Uses of the South Valley Floor Subwatershed

Beneficial Uses	Kings River (Pine Flat Dam to Stinson and Empire Weirs)	Kaweah River (Below Lake Kaweah)	Tule River (Below Lake Success)	Kern River (Below KR-1)	West Side Streams	Valley Floor Waters
Municipal & Domestic	E	E	E	E		
Agriculture	E	E	E	E	E	E
Industrial Service		E	E	E	E	E
Industrial Process	E	E	E	E	E	E
Hydropower Generation	E			E		
Water Contact Recreation	E	E	E	E	E	E
Non-Contact Water Recreation	E	E	E	E	E	E
Freshwater Habitat—Warm	E	E	E	E	E	E
Freshwater Habitat—Cold	E					
Wildlife Habitat	E	E	E	E	E	E
Rare, Threatened, or Endangered Species				E	E	E
Spawning, Reproduction, and/or Early Development	E					
Groundwater Recharge	E	E	E	E	E	E
Freshwater Replenishment	E					
Preservation of Biological Habitats of Special Significance						

E=Existing. KR-1: Southern California Edison Kern River Powerhouse No. 1.

Tulare Lake Basin Beneficial Uses categories vary slightly from the Sacramento San Joaquin Basin Plan Beneficial Uses categories, because they originate from separate Basin Plans.

The Kings River is further broken up by the Basin Plan as follows:

- **Reach I**—Above Kirch Flat,
- **Reach II**—Kirch Flat to Pine Flat Dam,
- **Reach III**—Pine Flat Reservoir to the Friant Kern Canal,
- **Reach IV**—Friant Kern Canal to Peoples Weir,
- **Reach V**—Peoples Weir to Island Weir.

Kings River Conservation District recognizes two additional reaches, as follows:

- **Reach VI**—Island Weir to Stenson Weir on the North Fork of the Kings River and to the Empire Weir No. 2 on the South Fork;
- **Reach VII**—Stinson Weir to the James Weir on the North Fork of the Kings River (Kings River Conservation District, Water Quality Report for the Kings River for the Period 1978 –1999, Vol. 1, December 2000).

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet water quality standards, or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. The Lower Kings River and Panoche Creek are listed as impaired in the 2002 CWA Section 303(d) list, last updated by the EPA in July of 2003.

According to the CWA Section 303(d) list, the Lower Kings River, from Island Weir to Stinson and Empire Weirs (approximately 36 miles), is impaired for EC, molybdenum, and toxaphene. Potential sources for these impairments are all considered to be agriculture. Panoche Creek, from Silver Creek to Belmont Avenue, is impaired for mercury, sedimentation/siltation, and selenium. Potential sources for mercury impairment are resource extraction, specifically abandoned mines. Potential sources of sedimentation/siltation impairment include agriculture, grazing, and highway/road/bridge construction. Table 3-132 contains the water quality criteria for molybdenum, toxaphene, and specific conductance. Table 3-132 contains the TMDL priority schedule for impairment of the Lower Kings River and Panoche Creek. No other waters in this subwatershed are listed as impaired.

Table 3-132. Impaired Status by River Sub-Areas

Watershed/Subwatershed	Pollutant	Potential Source	TMDL Priority	Estimated Size Affected
Lower Kings River (Island Weir to Stinson and Empire Weirs)	Electrical conductivity Molybdenum Toxaphene	Agriculture	Low	36 miles
Panoche Creek (Silver Creek to Belmont Ave)	Mercury Sedimentation/ Siltation Selenium	Resource extraction Agriculture Agriculture-grazing, highway, road/bridge construction	Low	18 miles

Data obtained from CWA Section 303(d).

Water Quality

Lower Kings River

The Lower Kings River is impaired for EC, molybdenum, and toxaphene. The potential source for all three of these contaminates is agriculture. Toxaphene is an amber waxy organic solid made of many chemicals that was typically used as an insecticide for cotton, vegetables, livestock and poultry. In 1982 the EPA cancelled most of its uses and it became regulated in 1992. It is now used only for special needs. However, because it can potentially remain in soil for up to 14 years, and accumulate in aquatic life, its presence remains problematic. Short-term exposure above the MCL can lead to central nervous system effects including restlessness, hyperexcitability, tremors, spasms, or convulsions. A lifetime of exposure at levels above the MCL can cause liver and kidney degeneration, central nervous system effects, possible immune system suppression, or cancer (EPA 2005). There is a limited amount of water quality data available on this reach of the Kings River. Data for toxaphene was collected at two USGS stations, 11223300 (Kings River below Empire Weir near Stratford) and 11221500 (Kings River below Pine Flat Dam), in October of 1992. Both samples were measured at 200 µg/L, which is well above the thresholds shown below in Table 3-133. In addition, the BDAT database was accessed in the hopes of obtaining more data. However, BDAT only contained pH values for the Kings River.

Table 3-133. Various Federal and State Water Quality Criteria

	Aquatic Life Criteria (µg/L)				Human Health Criteria (µg/L)			Agriculture (µg/L)
Compound	CTR—Chronic	CTR—Acute	EPA—Chronic	EPA—Acute	EPA—SNARL	CDHS	CTR—30-day average	Water Quality Limits
Molybdenum	N/A	N/A	N/A	N/A	40	N/A	N/A	10
Toxaphene	0.0002	0.73	0.0002	0.73	4	3	0.00073	N/A
Specific conductance (µmhos/cm)	N/A	N/A	N/A	N/A	N/A	900	N/A	300–600[1]

* Indicates an instantaneous maximum.

[1] Basin Plan EC objectives should be used:

Kings River:

Reach I (Above Kirch Flat) is 100 µmhos/cm.

Reach II (Kirch Flat to Pine Flat Dam) is 100 µmhos/cm with a maximum 10-year average of 50 µmhos/cm.

Reach III (Pine Flat Dam to Friant-Kern) is 100 µmhos/cm.

Reach IV (Friant Kern to People Weir) is 200 µmhos/cm.

Reach V (Peoples Weir to Island Weir) is 300 (however, during periods of low flow or 10% of the time, Reach V and VI are 400 and 600 µmhos/cm respectively).

Reach VI (Island Weir to Stinson Weir on North Fork and Empire Weir No. 2 on South Fork) is 300.

The Kings River also has specific EC objectives for specific streamflow stations. DWR station (C01140) Kings River below Peoples Weir has and EC objective of 198 µmhos/cm at the 90-percentile, 81 µmhos/cm median, and a 102 µmhos/cm mean. DWR station (C11460) Kings River below North Fork has and EC objective of 68 µmhos/cm at the 90-percentile, 48 µmhos/cm median, and a 47 µmhos/cm mean. DWR station (C11140) Kings River below Pine Flat Dam has an EC objective of 54 µmhos/cm at the 90-percentile, a 36 µmhos/cm median, and a 42 µmhos/cm mean.

Chronic levels are 4-day average, and acute levels are 1-hour maximum concentrations. CTR values are the 30-day average values for drinking water for the California Toxics Rule. NAS (National Academy of Sciences) SNARL. The specific conductance criteria for agriculture is based on the Basin Plan criteria. The EC objective is 300 during times of irrigation delivery, and 600 for 10% of the rest of the low flow season.

Sources: EPA 2003; Siepman and Finlayson 2000.

Molybdenum data was also limited and was only available from the same two USGS stations, 11223300 (Kings River below Empire Weir near Stratford) and 11221500 (Kings River below Pine Flat Dam), in October of 1992. At the upstream location (USGS 11221500), molybdenum was measured at 11 µg/L, exceeding agricultural water quality limits (Table 3-133). At the downstream location (USGS 11223300) molybdenum was measured at 2 µg/L, and did not exceed any thresholds. SWAMP (Surface Water Ambient Monitoring Program) data shows molybdenum levels at 2.5 µg/L. These levels do not exceed the thresholds presented in Table 3-133 (Kings River Conservation District 2004).

Specific conductance or EC is attributed to salinity or dissolved solids. EC data was also limited. At USGS 11221500 the only historical data from the 1960s was available. Kings River below Empire Weir (USGS 11223300) data was limited to two samples collected in 1992. The July sample results were 2500 µmhos/cm and the October sample results were 2630 µmhos/cm. Both of these concentrations are well over all thresholds shown in Table 3-133. SWAMP data indicates an increase in EC moving downstream. EC near Fresno Weir was 30 µS/cm, and though increasing, remained below the thresholds until South Fork at SR 41 where EC was measured at 1300 µS/cm, well above the thresholds from Table 3-133 (Kings River Conservation District 2004).

Panoche Creek

Please refer to the Coast Range Subwatershed section for further discussion of Panoche Creek water quality.

Tulare Lake Basin—Grapevine Subwatershed

General Description

The Grapevine Subwatershed makes up the southern boundary of the Tulare Lake Basinand is approximately 660,756 acres (about 1,032 square miles) (see Figure 3-48). The Grapevine Subwatershed is bounded on the north by the Fellows, South Valley Floor, and Kern River Subwatersheds. To the south are Ventura and Kern counties. To the west are San Luis Obispo and Santa Barbara counties and to the east is Kern County. The minimum elevation within the subwatershed is 610 feet, while the mean elevation is 4,063 feet and the maximum elevation is 8,819 feet.

The climate of the area is arid to semi-arid with dry, hot summers and mild winters. Summers have temperatures higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing. The area typically averages only 6.25 inches of annual rainfall. The winter snowpack, which accumulates above 5,000-foot elevation, primarily in the Sierra Nevada Mountains, supplies the vast majority of water in the basin. However, the elevations in this subwatershed are below the 5,000-foot mark, and rarely have snow. Additionally, the west side streams contribute little to the annual runoff within the basin.

Creeks in this subwatershed include both west side and east side creeks, flowing in the west and south from the Tehachapi Mountains toward the South Valley Floor and in the east from the Piute Mountains. Creeks from the west and south include Comanche Creek, Tecuya Creek, El Paso Creek, Pleito Creek, San Emigdio Creek, Bitterwood Creek, Sandy Creek, Salt Creek, Grapevine Creek, and Pastoria Creek. Creeks from the east include Calient Creek, and Walker Basin Creek, each with several tributaries. These creeks have intermittent ephemeral flows with much more of the water running off or providing limited irrigation, recreation, and groundwater recharge contributions to the South Valley. There is no flow data available on the USGS or CDEC websites.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation is the largest land use type of the subwatersheds, occupying approximately 97% or 638,175 acres (see Figure 3-58). DWR land use type (native vegetation) and FRAP land use types (conifer, desert, hardwood, herbaceous, and shrub) make up the native vegetation of the subwatershed. Urban land uses, including DWR land use type (commercial, industrial, residential, urban, urban landscape), and FRAP land use type (urban), occupy approximately 2% of the subwatershed or 14,236 acres. Irrigated agriculture, water, and barren land each occupy less than one percent of land—0.9%, 0.08%, and 0.19% respectively. (Table 3-134.)

Table 3-134. Land Use Acreage according to DWR and FRAP Land Use Data for the Grapevine Subwatershed

DWR Land Use	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	643	0.097
Field Crops	986	0.149
Grain and Hay	1,021	0.155
Pasture	2,361	0.357
Semiagricultural and Incidental	209	0.032
Truck, Nursery, and Berry Crops	762	0.115
Vineyards	5	0.001
Subtotal	5,987	0.906
Urban		
Urban—unclassified	1,124	0.170
Urban Landscape	182	0.028
Urban Residential	9,506	1.439
Commercial	300	0.045
Industrial	28	0.004
Vacant	425	0.064
Subtotal	11,565	1.75
Native		
Native Vegetation	292,840	44.319
Water Surface	236	0.036
Subtotal	293,076	44.355
FRAP Vegetation		
Agriculture	263	0.040
Barren/Other	875	0.132
Conifer	76,426	11.566
Desert	2,104	0.318
Hardwood	66,283	10.031
Herbaceous	128,249	19.409
Shrub	72,272	10.938
Urban	3,096	0.469
Water	348	0.053
Wetland	210	0.032
Subtotal	350,126	52.988
Total	**660,756**	**100**

Source: DWR 2005, CDF 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the Grapevine Subwatershed. The Tulare Lake Basin Plan combines all west side streams beneficial uses into one. Table 3-135 lists beneficial uses for the west side streams.

	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Ind	
Power	
Rec-1	E
Rec-2	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

P = Potential, E = Existing, U = Undefined.
Data obtained from the Sacramento San Joaquin River Basin Plan.
RARE = Rare, Threatened, or Endangered Species.
SPWN = Spawning, reproduction and or early development.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards, or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. There are no creeks or rivers within the Grapevine Subwatershed that are listed as impaired on the CWA Section 303(d) list.

Water Quality

The general water quality of the Grapevine Subwatershed is of good to excellent quality. As stated above, there is little to no irrigated agriculture within the Grapevine Subwatershed, and therefore, contaminants from agriculture are not expected to be found within the creeks of this subwatershed. The creeks within this subwatershed are dominated by flashy seasonal flows, and are expected to contain high total suspended solids for a short amount of time along with the possibility of heavy metals during the first flush period due to settled solids on the first couple layers of soil from grazing and or fires. Because this subwatershed contains no CWA Section 303(d) listings, water quality is not analyzed further.

Tulare Lake Basin—Coast Range Subwatershed

The Coast Range Subwatershed makes up the northwestern portion of the Tulare Lake Basin. Figure 3-49 identifies the Coast Range Subwatershed. To the north are San Benito and Merced Counties and to the south are Kings and Kern Counties. To the west are San Benito and Monterey Counties and to the east are Fresno and Kings Counties. The Coast Range Subwatershed is approximately 564,990 acres (about 883 square miles). The general topography of the Coast Range Subwatershed varies from small rolling hills to higher coastal mountains. The minimum elevation is 538 feet, the mean elevation is 2,051 feet, and the maximum elevation is 5,213 feet (DWR 2005).

The climate of the area is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing in lower elevations, though some higher elevations in the upper watershed experience extended freezing periods (Jones & Stokes 1998).

General Description

Panoche Creek

Panoche Creek drains out of the Coast Range down into the southern San Joaquin Valley floor. The Panoche Creek hydrology consists of many small tributaries that typically dry up during the summer months, and have flashy seasonal pulse flows during the storm season. Upstream tributaries to Panoche Creek (upstream of the Silver Creek inflow) include Grisswald Creek, Las Aguilas Creek, Payne Creek, and Antelope Creek. One of the most important downstream tributaries is Silver Creek, which is the last primary inflow to Panoche Creek. The upstream portion of Silver Creek receives inflow from San Carlos Creek. Much of this area does not contain irrigated agriculture until Panoche Creek drains down into the southern San Joaquin Valley floor, which is covered in the South Valley Floor Subwatershed section. The USGS website contained flow data for Panoche Creek but no data for any tributaries along Panoche Creek. Monthly average flow data for Panoche Creek from 1998 to 2004 are included in Table 3-136 below. The flow data for Panoche Creek near Interstate 5 (I-5) are from a station just outside the border of the Coast Range Subwatershed; however, it is the best representative flow station available for the watershed. The flow data validate the flashy storm-season pulse flows that occur in Panoche Creek.

Southern Coast Range Subwatershed Drainages

Many small tributaries in the southern portion of the Coast Range Subwatershed contain seasonal pulse flows. The main creeks are Cantua Creek, Martinez Creek, Salt Creek, Domengine Creek, and Los Gatos Creek. The portions of these creeks that are within the Coast Range Subwatershed do not contain irrigated agriculture. However, during the storm season, flows from these seasonal creeks drain down into the southern San Joaquin Valley where agriculture is present. The USGS website contained flow data for Los Gatos Creek and Cantua Creek. No flow data were available for other creeks. Monthly average flow data from 1995 to 2004 for Los Gatos Creek and Cantua Creek are included in Table 3-136 below. Flow data represent the flashy storm-season pulse flows that occur in these West Side drainages.

Table 3-136. Monthly Average Flow for the Coast Range Subwatershed

	Panoche Creek near I-5 (11255575)			Los Gatos Creek near Coalinga California (11224500)			Cantua Creek near Cantua Creek California (11253310)		
Month	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Jan	0	0.5	3	0	17	111	0	7	31
Feb	0	53	316	0.25	25	160	0.1	11	64
Mar	0	5	23	0.04	36	237	0.1	17	102
Apr	0	2	11	0	9	35	0.2	5	21
May	0	0.8	4	0	7	43	0	3	14
Jun	0.1	0.7	2	0	2	13	0	1	7
Jul				0	0.6	4	0	0.5	3
Aug				0	0.2	2	0	0.1	1
Sep		No Data		0	0.2	1	0	0.1	1
Oct				0	0.3	1	0	0.1	1
Nov				0	0.5	2	0	0.2	2
Dec	0	0.4	2	0	2.5	12	0	1.1	5

Panoche Creek data are from 1998 to 2004, and Los Gatos Creek and Cantua Creek data are from 1995 to 2004.
Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Urban land use equals a very small portion of the land use within the Coast Range Subwatershed. The total urban land use is 2,859 acres, which is 0.5% of the total acreage within the subwatershed. Native vegetation makes up the largest land use in the Coast Range Subwatershed.

Total irrigated land within the subwatershed is 8,506 acres or 1.5% of land use. Irrigated land includes deciduous fruits and nuts, field crops, grain and hay crops, semi-agriculture, truck, nurseries, berry crops, and vineyards. The largest irrigated crop is grain and hay, which use 8,343 of the 8,506 acres. Table 3-137 below includes all DWR and FRAP land uses within the Coast Range Subwatershed. See also Figure 3-59.

Table 3-137. Land Use Acreage according to DWR and FRAP Land Use Data for the Coast Range Subwatershed

DWR Land Use	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	46	0.01
Field Crops	1	0.0001
Grain and Hay Crops	8,343	1.46
Semiagricultural & Incidental to Agriculture	80	0.01
Truck, Nursery, and Berry Crops	9	0.002
Vineyards	27	0.005
Subtotal	8,506	1.4871
Urban		
Urban—unclassified	53	0.01
Industrial	2,453	0.43
Subtotal	2,506	0.44
Native		
Native Vegetation	450,328	78.56
Riparian Vegetation	128	0.02
Subtotal	450,456	78.58
FRAP Vegetation		
Conifer	438	0.08
Hardwood	65,244	11.38
Herbaceous	12,901	2.25
Shrub	32,844	5.73
Urban	352	0.06
Subtotal	111,779	19.5
Total	**573,247**	**100**

Basin Plan Status

The Tulare Lake Basin Plan (Basin Plan with 2004 Approved Amendments) describes beneficial uses for waters within the Coast Range Subwatershed. Table 3-138 lists beneficial uses for west side streams.

Table 3-138. Beneficial Uses for the West Side Streams

	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Industry	
Power	
Rec-1	E
Rec-2	E
Freshwater Habitat——Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

P = Potential, E = Existing, U = Undefined.
RARE = Rare, Threatened, or Endangered Species.
SPWN = Spawning, Reproduction and/or Early Development.
Source: Water Quality Control Plan for the Tulare Lake Basin (Basin Plan) (Second Edition with 2004 Approved Amendments).

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet, water quality standards or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. Panoche Creek (Silver Creek to Belmont Avenue) and San Carlos Creek are listed as impaired in the 2002 CWA Section 303(d) list that was last updated by the EPA in July 2003. Identified sources of impairment in Panoche Creek and San Carlos Creek are agriculture, agriculture-grazing, resource extraction (mining), and highway/road/bridge construction.

According to the CWA Section 303(d) list of water quality–impaired rivers, Panoche Creek is listed as impaired for mercury, sedimentation/siltation, and selenium. The TMDL priority for these impairments is considered low. San Carlos Creek, a tributary to Silver Creek, which is a tributary to Panoche Creek, is listed as impaired for mercury. This TMDL priority is also considered low. Table 3-139 below includes the 303(d) list for the Coast Range Subwatershed.

Table 3-139. CWA Section 303(d) Impaired Status for the Coast Range Subwatershed

Watershed/Subwatershed	Pollutant	Potential Sources	TMDL Priority	Size
Panoche Creek (Silver Creek to Belmont Avenue)	Mercury	Resource Extraction	Low	18 Miles
	Sedimentation/Siltation	Agriculture/Agriculture-Grazing/ Highway/Road/Bridge Construction		
	Selenium			
San Carlos Creek	Mercury	Resource Extraction/Acid Mine Drainage	Low	5.1 Miles

Data obtained from CWA Section 303(d).

Water Quality

Many small creeks drain into the southern San Joaquin Valley from the Coast Range. When this drainage occurs during the storm season, Panoche and San Carlos Creeks carry a high sediment and heavy metal load. Mercury impairments are a result of resource extraction from abandoned mines. Sedimentation/siltation and selenium are a result of agriculture, agriculture-grazing, and construction. However, a USGS document identifies Panoche Creek and Silver Creek as having some of the world's largest natural deposits of selenium (USGS 2005a). This natural selenium along with similar deposits of boron and other salts contributes to the contamination of Panoche Creek. In addition, development of the lower watershed has virtually eliminated the creek channel, promoting flooding and sediment transport depositing selenium, boron, and other salts into the downstream watershed (USGS 2005a).

The Arroyo Pasajero Watershed is located on the eastern slope of the Coast Ranges in southwestern Fresno County. Several creeks flow from the watershed into Pleasant Valley and form Arroyo Pasajero Creek east of Coalinga and west of the California Aqueduct. The largest of these creeks is Los Gatos Creek. There are several inactive or abandoned asbestos mines in the watershed. Two of these mines, the Coalinga Asbestos Mine and the Atlas Asbestos Mine, are Superfund cleanup sites. The Atlas Mine is located at the head of White Creek and the Coalinga Mine is located at the head of Pine Canyon Creek. Both White Creek and Pine Canyon Creek are tributaries of Los Gatos Creek. There is a possibility that asbestos fibers from the watershed migrate to the California Aqueduct through the Arroyo Pasajero Inlet. Waterborne asbestos fibers may be carcinogenic given a sufficient quantity and prolonged, constant exposure.

Unfortunately, water quality data sources are limited for both locations. The USGS or BDAT website does not contain any water quality information for San Carlos Creek. However, the USGS website does contain some historical water quality data for Panoche Creek from the 1960s that only covers temperature and suspended sediment. The temperature data were within basin plan standards. Suspended sediment concentrations had a minimum of 1,310 mg/L, an average of 18,552 mg/L, and a maximum of 38,900 mg/L from 1965 to 1967 (USGS 2005b).

Tulare Lake Basin—Fellows Subwatershed

General Description

The Fellows Subwatershed is the smallest in terms of area within the Tulare Lake Basinand accounts for approximately 34,398 acres (about 54 square miles). To the north is the Temblor Subwatershed, and to the south is the Grapevine Subwatershed. To the east is the South Valley Floor Subwatershed, and to the west is San Luis Obispo County. The general topography of the Fellows Subwatershed is typical of the Coast Range Mountains. The minimum elevation is 1,099 feet while the mean elevation is 2,399 feet and the maximum elevation is 3,944 feet (DWR 2005). Figure 3-50 identifies the Fellows Subwatershed.

The climate of the area is arid to semi-arid with dry, hot summers and mild winters. Summer temperatures may be higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing. The area typically averages less than 10 inches of annual rainfall. However, the elevations of the Fellows Subwatershed are below the 5,000 feet mark, and rarely have snow. As a result, the west side streams contribute little to the annual runoff within the basin.

A few small creeks drain into the Tulare Lake Bed from the Fellows Subwatershed. These coastal creeks tend to have flows only during the storm season and tend to ephemeral. From north to south the creeks are Buena Vista Creek, Broad Creek, Sandy Creek, and Bitterwater Creek. There is no available flow data for any of these creeks on the USGS or CDEC websites. However, the City of Taft discharges to Sandy Creek and has an NPDES permit with the Central Valley Water Board.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only sources of land use data in which crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Virtually all of the land use within the Fellows Subwatershed is native vegetation (see Figure 3-60). Approximately 15% is desert, and 0.02% (6 acres) is defined as urban land use. The DWR land use data and FRAP vegetation data does not define any irrigated agriculture in the Fellows Subwatershed. Table 3-140 contains DWR and FRAP land use data.

Table 3-140. DWR and FRAP Land Use Data for Fellows Subwatershed

DWR Land Use	Acres	Percent Total
Native Vegetation	15,685	45.6
FRAP Vegetation		
Desert	5,075	14.75
Hardwood	272	0.79
Herbaceous	13,359	38.84
Urban	6	0.02
Total	**34,398**	**100**

Source: DWR 2004 and FRAP 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the Fellows Subwatershed. The Tulare Lake Basin Plan combines all beneficial uses of the west side streams into one. Table 3-141 lists beneficial uses for the west side streams.

Table 3-141. Beneficial Uses based on the Tulare Lake Basin Plan

	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Industry	
Power	
Rec-1	E
Rec-2	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Freshwater Replenishment	

P = Potential, E = Existing, U = Undefined. RARE = Rare, Threatened, or Endangered Species. SPWN = Spawning, reproduction and or early development.

Source: Water Quality Control Plan for the Tulare Lake Basin (Basin Plan) (Second Edition with 2004 Approved Amendments).

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet water quality standards, or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. There are no creeks or rivers within the Fellows Subwatershed listed as impaired on the CWA Section 303(d) list.

Water Quality

The general water quality of the Fellows Subwatershed is of good to excellent quality. As stated above, there is no irrigated agriculture within the Fellows Subwatershed, therefore contaminants from agriculture are not expected to be found within the creeks. However, since the creeks within this subwaterhed are dominated by flashy seasonal flows, they are expected to contain high total suspended solids for a short amount of time, along with the possibility of heavy metals during the first flush period. Because this subwatershed contains no CWA Section 303(d) listings, water quality is not analyzed further.

Tulare Lake Basin—Temblor Subwatershed

General Description

The Temblor Subwatershed is part of the Coast Range Mountains on the west side of the Tulare Lake Basin. North is the Sunflower Subwatershed and south is the Fellows Subwatershed. East is the South Valley Floor Subwatershed and west is San Luis Obispo County. The Temblor Subwatershed is approximately 176,279 acres (about 275 square miles). Topography in the Temblor Subwatershed is typical of the Coast Range Mountains. The minimum elevation is 502 feet while the mean elevation is 3,783 feet and the maximum elevation is 4,285 feet (DWR 2005). Figure 3-51 shows the Temblor Subwatershed.

The climate of the area is arid to semi-arid with dry, hot summers and mild winters. Summers experience temperatures higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing. The area typically averages less than 10 inches of annual rainfall. The winter snowpack, which accumulates above 5,000 feet elevation, primarily in the Sierra Nevada Mountains, supplies the vast majority of water in the basin.

Many small creeks drain into the Tulare Lake Bed from the Temblor Subwatershed, however most are ephemeral. From north to south these creeks include the Francisco Creek, Packwood Creek, Bitterwater Creek, Devilwater Creek, Media Agua Creek, Walnut Creek, Yeguas Creek, Santos Creek, Chico Martinez Creek, and Temblor Creek. No flow data are available for any of these creeks on the USGS or CDEC websites.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only source of land use data where crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Like most other subwatersheds that are not within the southern San Joaquin Valley floor, native vegetation is the dominate land use and accounts for over 90% of the land cover (Figure 3-61). Urban land use was calculated by combining DWR industrial with FRAP urban. The total urban land use is 586 acres or 0.33% of land use. Total irrigated agriculture was calculated by combining DWR grain and hay crops, semiagriculture, vineyards, and FRAP agriculture. The total irrigated agriculture accounted for approximately 5,822 acres or 3.3% of the land use. Table 3-142 below contains all DWR and FRAP land use data for the Temblor Subwatershed.

Table 3-142. DWR and FRAP Land Use of the Temblor Subwatershed

DWR Land Use	Acres	Percent Total
Grain and Hay Crops	5,581	3.166
Industrial	2	0.001
Native Vegetation	101,763	57.728
Semiagricultural & Incidental to Agriculture	63	0.036
Vineyards	50	0.029
Water Surface	56	0.032
FRAP Vegetation		
Agriculture	128	0.073
Barren/Other	96	0.055
Conifer	727	0.412
Desert	1,918	1.088
Hardwood	8,351	4.737
Herbaceous	48,586	27.562
Shrub	8,369	4.747
Urban	584	0.331
Water	5	0.003
Total	**176,279**	**100**

Source: DWR 2005; CDF 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the Temblor Subwatershed. The Tulare Lake Basin Plan combines all west side streams beneficial uses into one. Table 3-143 lists beneficial uses for the west side streams.

Table 3-143. Beneficial Uses based on the Tulare Lake Basin Plan

	West Side Streams
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Ind	
Power	
Rec-1	E
Rec-2	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

P = Potential, E = Existing, U = Undefined. Data obtained from the Sacramento San Joaquin River Basin Plan. RARE = Rare, Threatened, or Endangered Species. SPWN = Spawning, reproduction and or early development.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet water quality standards, or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. There are no creeks or rivers within the Temblor Subwatershed that are listed as impaired on the CWA Section 303(d) list.

Water Quality

The general water quality of the Temblor Subwatershed is of good to excellent quality. As stated above, irrigated agriculture only accounts for 3.3% of the land use within the subwatershed, and therefore, contaminants from agriculture are not expected to be found within the creeks of this subwatershed. The creeks within this subwatershed are dominated by flashy seasonal flows, and are expected to contain high total suspended solids for a short amount of time along with the possibility of heavy metals during the first flush period. Because this subwatershed contains no CWA Section 303(d) listings, water quality is not analyzed further.

Tulare Lake Basin—
Sunflower Valley Subwatershed

General Description

The Sunflower Valley Subwatershed is part of the Coast Range Mountains on the west side of the Tulare Lake Subwatershed. North of the Sunflower Valley Subwatershed is the Coast Range Subwatershed, south is the Temblor Subwatershed. To the east is the South Valley Floor Subwatershed, and to the west are Monterey and San Luis Obispo counties. The Sunflower Valley Subwatershed is approximately 93,042 acres (about 145 square miles). The general topography of the Sunflower Valley Subwatershed is typical of the Coast Range Mountains. The minimum elevation within the Subwatershed is 453 feet, the mean elevation is 1,554 feet, and the maximum elevation is 4,324 feet (DWR 2005). Figure 3-52 shows the Sunflower Valley Subwatershed.

The climate of the area is arid to semi-arid with dry, hot summers and mild winters. Summers experience temperatures higher than 100°F for extended periods of time; winter temperatures are only occasionally below freezing. The area typically averages less than 10 inches of annual rainfall. The winter snowpack, which accumulates above 5,000 feet elevation, primarily in the Sierra Nevada Mountains, supplies the vast majority of water in the basin.

Like the Coast Range Subwatershed, flashy seasonal streams tend to dominate during the storm season and dry up during the summer months. There are five main creeks that make up the Sunflower Valley Subwatershed. From north to south they are Garza Creek, Baby King Creek, Big Tar Creek, Avenal Creek, and Cottonwood Creek. The USGS and CDEC websites only contained flow data for one of the creeks found within the Sunflower Valley Subwatershed. Monthly minimum, mean, and max flows from 1975 to 1986 for Avenal Creek are included in Table 3-144 below.

Table 3-144. Monthly flows for Avenal Creek near Avenal California (11197250)

Date	Min	Mean	Max
January	0	5.7	28.9
February	0	23.8	111.8
March	0	14.4	44.6
April	0	4.7	17.0
May	0	1.5	9.2
June	0	0.6	4.7
July	0	0.3	2.0
August	0	0.2	1.2
September	0	0.2	1.4
October	0	0.2	0.7
November	0	0.3	1.6
December	0	2.9	11.9

Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only source of land use data in which crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation makes up more than 92% of the Sunflower Valley Subwatershed (Figure 3-62). According to FRAP data, total urban land use makes up only 0.08% of the land within the Sunflower Valley Subwatershed. Total irrigated agriculture was calculated by combining deciduous fruits and nuts, field crops, grain and hay crops, pasture, semiagriculture, and vineyards. As a result, irrigated agriculture accounts for approximately 611 acres or 0.7% of land use within the subwatershed. Of 611 acres, 457 acres are pasture, which may or may not be irrigated land. Table 3-145 includes all DWR land use and FRAP vegetation data.

Table 3-145. DWR Land Use and FRAP Vegetation Data of Sunflower Valley Subwatershed

DWR Land Use	Acres	Percent Total
Deciduous Fruits and Nuts	19	0.02
Field Crops	1	0.002
Grain and Hay Crops	76	0.08
Native Vegetation	85,445	91.84
Pasture	457	0.49
Semiagricultural and Incidental to Agriculture	3	0.003
Vineyards	55	0.06
Water Surface	2	0.002
FRAP Vegetation		
Hardwood	400	0.43
Herbaceous	4,103	4.41
Shrub	2,411	2.59
Urban	70	0.08
Total	**93,042**	**100**

Source: DWR 2005; FRAP 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the Sunflower Valley Subwatershed. The Tulare Lake Basin Plan combines all beneficial uses of the west side streams into one. Table 3-146 lists beneficial uses for the west side streams.

Table 3-146. Beneficial Uses based on the Tulare Lake Basin Plan

West Side Streams	
Municipal & Domestic	
Irrigation	E
Industrial	E
Stock Watering	
Proc	E
Ind	
Power	
Rec-1	E
Rec-2	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	
SPWN	
Wildlife Habitat	E
RARE	E
Groundwater Recharge	E
Fresh Water Replenishment	

P = Potential, E = Existing, U = Undefined. Data obtained from the Sacramento San Joaquin River Basin Plan. RARE = Rare, Threatened, or Endangered Species. SPWN = Spawning, reproduction and or early development.

Impaired Status

CWA Section 303(d) requires the identification of water bodies that do not meet, or are expected not to meet water quality standards, or are considered impaired. The affected water body and associated pollutant is then prioritized in the 303(d) list. There are no creeks or rivers within the Sunflower Valley Subwatershed that are listed as impaired on the CWA Section 303(d) list.

Water Quality

The general water quality of the Sunflower Valley Subwatershed is of good to excellent quality. As stated above, irrigated agriculture only account for 0.66% of the land use within the Subwatershed, and therefore, contaminants for agriculture are not expected to be found within the creeks of this subwatershed. The creeks within this subwatershed are dominated by flashy seasonal flows, and are expected to contain high total suspended solids for a short amount of time, with the possibility of heavy metals during the first flush period. Because this subwatershed contains no CWA Section 303(d) listed water bodies, water quality is not analyzed in detail any further.

Tulare Lake Basin—
Southern Sierra Subwatershed

General Description

The Tule River, Deer Creek, and White River are the main watersheds in the overall Southern Sierra Subwatershed. Together they occupy 665,472.83 acres of generally steep topography (DWR 2005). Figure 3-53 below delineates the Southern Sierra Subwatershed.

Climate in this subwatershed varies with elevation. At lower elevations (valley floor to 2,000–3,000 feet) the climate is hot summer Mediterranean, with hot dry summers and mild winters with very little snowfall. At elevations of 2,000–3,000 feet to 6,000–7,000 feet. is the cool summer climate characterized by warm dry summers and cool winters with the precipitation a mix of rain and snow. The highest altitude in the subwatershed has a Lower Boreal climate. Elevations with this climate type are typically above 6,000–7,000 feet. and run to the nearest timberline (9,000–10,000 feet) (Sierra Nevada Photos).

Tule River

The Tule River Watershed is located on the western slope of the Southern Sierra Nevada and is bordered by the Kaweah Watershed to the north and the Deer Creek Watershed to the south. More than half of the mountain portion of the watershed lies within Sequoia National Forest. The maximum elevation is 10,050 feet; however, only about 5% of the watershed is above 8,000 feet. The southern portion of the subwatershed includes the Tule River Indian Reservation. Tule River’s three forks, the North, Middle, and South, flow southwest or west into Success Reservoir. All three forks are fed by a multitude of small streams, with slopes ranging from 400 feet per mile to about 1000 feet per mile. Tule River flow varies seasonally, with the lowest flows in the late summer (August and September) and the highest flows in the spring (February through May) (see Table 3-147).

Deer Creek

Deer Creek Watershed is located south of the Tule River Watershed and north of the White River Watershed. Steep mountainous terrain makes up the majority of the upper Deer Creek watershed, which drains the western slope of the Greenhorn Mountains, which is part of the Sierra Nevada Mountains. The maximum elevation in the Deer Creek Watershed is 8,300 feet. Water generally flows west from this elevation through the foothills and crosses the South Valley. Flow data was not available for Deer Creek in the Southern Sierra Subwatershed. For more information on the lower portion of Deer Creek and its downstream flow, see the South Valley Floor section.

White River

The White River Watershed, located south of Deer Creek Watershed and north of Poso Creek Watershed, drains a portion of the Greenhorn Mountains, flowing westward into the South Valley toward Tulare Lakebed. For additional information on the lower reaches of White River, see the South Valley Section. Like the Deer Creek Watershed, the maximum elevation in the White River Watershed is 8,300 feet, with steep mountainous terrain in the upper watershed and foothills as White River approaches the valley floor. Flow data was not available for White River in the Southern Sierra Subwatershed. For downstream flow data see the South Valley section.

Table 3-147. Monthly Average Flow on the Tule River (cfs)

	Min	Mean	Max
Jan	13	163	666
Feb	9	278	954
Mar	82	342	1130
Apr	67	322	989
May	51	262	948
Jun	23	153	902
Jul	1	59	361
Aug	0	22	144
Sep	0	20	80
Oct	3	38	105
Nov	4	86	274
Dec	10	157	582

Source: USGS website.

Land Use Patterns

Significant differences in irrigated acres and crop types were apparent among available information sources, but the relative proportions of each crop type were similar. The DWR and FRAP land use data were used for the purposes of this report. These were the only source of land use data where crop types could be identified and delineated by drainage areas. The DWR land use data were used for the purposes of mapping land use. The DWR methods use aerial photos and rely on field staff to observe the types of land use and record the data into GIS databases. The FRAP data were used as a supplement to the DWR data because the DWR data set is incomplete in some areas. The possibility exists to categorize dryland crops as irrigated crops and may create a small amount of crossover.

Native vegetation makes up approximately 98% of land use in the Southern Sierra Subwatershed. Native vegetation includes DWR land use types native vegetation and riparian vegetation as well as FRAP land use types conifer, hardwood, herbaceous, and shrub. Urban, irrigated agriculture, surface water and barren land each make up less than one percent of land use in the region, with approximately 0.3%, 0.2%, 0.4%, and 0.6% respectively; See Figure 3-63. This can be attributed to the large Sequoia National Forest and Tule Indian Reservation land holdings. Existing land use in the Southern Sierra Subwatershed is shown in Table 3-148.

Table 3-148. DWR and FRAP Land Use for the Southern Sierra Subwatershed

DWR Land Use Type	Acres	Percent Total
Agriculture		
Deciduous Fruits and Nuts	119	0.018
Grain and Hay Crops	222	0.033
Idle	72	0.011
Pasture	910	0.137
Semiagricultural and Incidental to Agriculture	101	0.015
Vineyards	2	0.0003
Subtotal	1,426	0.2143
Urban		
Urban—unclassified	762	0.114
Urban Landscape	159	0.024
Commercial	55	0.008
Industrial	157	0.024
Residential	633	0.095
Vacant	22	0.003
Subtotal	1,788	0.268
Native		
Native Vegetation	142,278	21.380
Riparian Vegetation	715	0.107
Water Surface	2,644	0.397
Subtotal	145,637	21.884
FRAP Land Use Type		
Barren/Other	4,440	0.667
Conifer	104,322	15.676
Hardwood	239,054	35.922
Herbaceous	131,923	19.824
Shrub	36,011	5.411
Urban	674	0.101
Water	22	0.003
Wetland	175	0.026
Subtotal	516,621	77.63
Total	**665,473**	**100**

Source: DWR 2005, CDF, 2005.

Basin Plan Status

The Tulare Lake Basin Plan (Second Edition with 2004 Approved Amendments) describes beneficial uses for waters within the Southern Sierra Subwatershed. Table 3-149 lists the beneficial uses of the Tule River above Success Dam.

Table 3-149. Beneficial Uses by Subwatershed

Beneficial Uses	Tule River above Lake Success
Municipal and Domestic	E
Agriculture	E
Industrial Service	
Industrial Process	
Hydropower Generation	E
Water Contact Recreation	E
Non-Contact Water Recreation	E
Freshwater Habitat—Warm	E
Freshwater Habitat—Cold	E
Wildlife Habitat	E
Rare, Threatened, or Endangered Species	E
Spawning, Reproduction, and/or Early Development	E
Groundwater Recharge	
Freshwater Replenishment	E
Preservation of Biological Habitats of Special Significance	

E = Existing. Beneficial Use categories in the Tulare Lake Basin vary slightly from those in the Sacramento–San Joaquin Basin Plan
Source: Tulare Lake Basin Plan.

Impaired Status

CWA Section 303(d) requires the identification of waterbodies that do not meet, or are not expected not to meet, water quality standards, or are considered impaired. The affected waterbody and associated pollutant are then prioritized in the 303(d) list. The Tule River is not listed as impaired in the 2002 CWA Section 303(d) list that was last updated and approved by the EPA in July of 2003.

Water Quality

The water quality on the Tule River is of good to excellent quality. As stated earlier, no 303(d) listed pollutants are associated with the Tule River. Generally, all physical parameters such as EC, pH, temperature, and turbidity are within Basin Plan standards.